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FINAL REPORT

ON

DESIGN AND MANUFACTURE OF SEALED NICKEL-CADMIUM CELLS OF CYLINDRICAL DESIGN TO SIGNAL CORPS TECHNICAL REQUIREMENT SCL-7504 A

DECEMBER 1, 1959 TO MARCH 31, 1963

REPORT NO. 4

CONTRACT NO. DA-36-039 SC-84496

FILE NO. 40541-PM-60-93-93

DA TASK NO. 3G18 03 001 02

PLACED BY U.S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY FORT MONMOUTH, NEW JERSEY

SONOTONE CORPORATION
ELMSFORD, NEW YORK

FINAL REPORT

on

Design and Manufacture of Sealed
Nickel-Cadmium Cells of Cylindrical
Design to Signal Corps Technical
Requirement SCL-7504A, June 28, 1961

December 1, 1959 to March 31, 1963

Report No. 4

Contract No. DA-36-039 SC-84496
File No. 40541-PM-60-93-93
DA Task No. 3G 1803 001 02

Object: The Design and Manufacture of
60 Engineering Test Models of Each
of 3 Sizes of Sealed, Cylindrical
Nickel-Cadmium Cells, viz.
10 A.H., 50 A.H. and 100 A.H. Capacity

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I. PURPOSE

The purpose of this contract is the design and manufacture of 60 engineering test models of each of three sizes of sealed nickel-cadmium cells, viz. 10 A.H., 50 A.H. and 100 A.H. capacity, measured at the five hour rate, meeting the requirements of SCL-7504A. These requirements are as follows:

The cells shall be cylindrical and have a reuseable pressure relief valve.

The cells shall yield 50% of their nominal capacity when discharged at the 5 hour rate at minus 40°F to 1.0 volt, and shall yield 75% when discharged to 1.0 volt at the $3C_5$ rate at room temperature.

Although no definite requirement is specified for life test or for storage, design objectives are for 5000 continuous cycles of 20% depth of discharge and for storage in a discharged state for 5 years from minus 80°F to 165°F without any degradation of performance.

The batteries shall be capable of passing the following environmental tests after which they shall meet full specification requirements: temperature shock, high and low frequency vibration, mechanical shock, acceleration and elevation. All of these environmental tests are described fully in the appropriate section of this report.

II. ABSTRACT

The sixty cells of each of three sizes (10 A.H., 50 A.H. and 100 A.H.) have been manufactured. The qualification tests of SCL-7504A have been successfully passed and all cells have been delivered. All 10 A.H. and 50 A.H. cells had teflon sealed terminals. In the 100 A.H. size, 40 cells had teflon seals and 20 cells had ceramic seals. Fifty each of the 50 A.H. and 100 A.H. cells have been partially scored to immobilize the core assembly in order to withstand the severe vibration and shock requirements of SCL-7504A. Parts lists and pertinent drawings of all types of cells have been included in this report.

III. REFERENCES AND CONFERENCES

A. References

1. Final Report - "Study of Sealed Nickel-Cadmium Batteries", (1960) Sonotone Corporation DA 36-039 SC-78249.

2. Final Report - "Investigation Leading to the Development of a Nickel-Cadmium Battery Having a Hermetically Sealed Construction", (1957) Sonotone Corporation DA 36-039 SC-73009

3. "The Hermetically Sealed Sintered Plate Nickel-Cadmium Cell", L. Belove and I. Schulman, Proceedings of the Thirteenth Annual Battery Research and Development Conference, April 30, 1959.

4. First, Second and Third Quarterly Reports - "Design and Manufacture of Sealed Nickel-Cadmium Cell of Cylindrical Design to Signal Corps Technical Requirement SCL-7504".

5. Technical Program Letter Report - "Design and Manufacture of Sealed Cylindrical Nickel-Cadmium Cells", (1961) Sonotone Corporation - DA 36-039 SC-84496.

III. REFERENCES AND CONFERENCES (continued)

B. Conferences

Date	Location	USAERDL Representatives Present	Sonotone Representatives Present
12-15-59	Ft.Monmouth, N.J.	H. Mandel A. Frink D. Clark	Dr.G.A.Baumstark H. Bilsky F. Alliegro
3-15-60	Elmsford, N.Y.	R. Lunz	Dr.G.A.Baumstark L. Belove W. Ryan H. Bilsky A. Mundel F. Alliegro
5-13-60	Ft.Monmouth, N.J.	H. Mandel R. Lunz A. Frink	H. Bilsky F. Alliegro
7-6-60	Elmsford, N.Y.	Dr. E. Baars R. Lunz	W. Ryan H. Bilsky F. Alliegro
8-31-60	Ft.Monmouth, N.J.	P. Rappaport H. Mandel R. Lunz	H. Bilsky F. Alliegro
9-14-60	Ft.Monmouth, N.J.	Dr. A.Fishbach H. Mandel R. Lunz	D. Goldstein F. Alliegro
11-2-60	Elmsford, N.Y.	R. Lunz	Dr.G.A.Baumstark W. Ryan F. Alliegro
1-13-61	Ft.Monmouth, N.J.	H. Mandel P. Rappaport R. Lunz	Dr.G.A.Baumstark S. Richman F. Alliegro
4-7-61	Elmsford, N.Y.	R. Lunz	F. Alliegro

III. REFERENCES AND CONFERENCES (continued)

B. Conferences (continued)

Date	Location	USAERDL Representatives Present	Sonotone Representatives Present
4-26-61	Ft.Monmouth, N.J.	Mrs. S. Duze H. Mandel P. Rappaport	F. Alliegro
8-30-61 thru 9-1-61	Elmsford, N.Y.	Mrs. S. Duze	F. Alliegro
1-11-62	Ft.Monmouth, N.J.	Mrs. S. Duze P. Rappaport	A. Mundel F. Alliegro
7-20-62	Ft.Monmouth, N.J.	Mrs. S. Duze P. Rappaport H. Getzlaff S. Del Vecchio	Dr.G.A.Baumstark W. Vignini F. Alliegro
10-16-62 thru 10-18-62	Elmsford, N.Y.	Mrs. S. Duze	F. Alliegro
2-12-63 and 2-13-63	Elmsford, N.Y.	Mrs. S. Duze	F. Alliegro

The conferences up to and including that of 4-26-61 have been described in the first three Quarterly Reports of this contract and in the one Technical Program Letter Report.

The conferences of 8-30-61, 10-16-62 and 2-12-63 were held to enable Mrs. Duze to witness qualification testing (especially the environmental tests) of the cells produced under this contract.

On 1-11-62 the difficulties encountered in the ceramic sealing of large terminals were discussed, and a new mechanical design

III. REFERENCES AND CONFERENCES

B. Conferences (continued)

of these seals was presented.

At the conference of 7-20-62, Messrs. Del Vecchio and Getzlaff presented suggestions pertaining to the various elements of ceramic sealing, especially brazing alloys, metallizing materials and ceramic composition. Also, at this meeting, Sonotone agreed to supply intercell connectors and related hardware for the cells previously shipped under the contract.

IV. DATA AND DISCUSSION

A. Difficulties Encountered

Several extensions of this contract have been required. The first of these, extending the time of the contract from November 30, 1960 to May 29, 1961, was requested to enable Sonotone to evaluate and select a separator superior to the then standard cellulosic material. Another reason for this extension was the need for unusual support and immobilization of the cores of the cells, especially in view of the heavy stack-ups and the severe vibration and shock requirements of SCL-7504.

A second extension to November 20, 1961 was requested and granted, mainly to incorporate our improved method of terminal sealing (ceramic to metal bonding). This new type of seal was to apply to 50 each of the 100 A.H. and 50 A.H. cells. All of the 10 A.H. cells (60) and 10 each of the two larger sizes were made with Teflon seals. The 10 A.H. cells were shipped on 10-17-61, while ten 100 A.H. and ten 50 A.H. cells (Teflon seals) were shipped on 11-28-61.

A third extension to 3-31-62 was requested when it was discovered that ceramic seals identical to those to be supplied on this contract developed leaks after several months of use by other customers.

IV. DATA AND DISCUSSION

A. Difficulties Encountered (continued)

Difficulties with the delivery of ceramic sealed covers from a vendor made it necessary to procure a further extension to 6-30-62.

Further difficulties with the low percentage of acceptable covers from the supplier, plus defective bar stock (from which the cover blanks had been made) caused more delays, with the result that the contract time was extended to 3-31-63.

The above difficulties and the manner in which they have been resolved are described in detail in the following section of this report, which summarizes the project under the various elements of the designs such as plates, separator, etc.

B. Summary

1. Plates

To meet the high rate ($3C_5$) and the low temperature ($-40^{o}F$) requirements of SCL-7504A, thin plates were used (approx. 0.023") along with a theoretical N/P ratio of 2. The loading of the plates with active material was 1.35g/cc for the positive and 2.2g/cc for the negative, both being approximately 30% over the normal loading. In the positive plates, 5% of the active material is Cobaltous Hydroxide.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

1. Plates (continued)

Stacked rectangular plates were used instead of spirally wound plates even though the latter gives a much greater cross-section efficiency. However, the rectangular core design made possible lighter and less bulky current carrying hardware inside the cells. In addition, the stacked rectangular plates afford maximum reliability and less difficult manufacturing procedures.

On all cells, approximately 9 square inches of positive plate was used per ampere hour of nominal capacity, with an equal area of negative plate. In the 10 A.H. cells, two plate widths were used, while in the 50 A.H. and 100 A.H. cells, three plate widths were used to afford maximum utilization of the cross-section area (Figure 1).

2. Separator

Due to the high temperature storage requirement and the requirement for efficient operation at temperatures as high as 125°F, several materials were investigated to either replace or complement the cellulosic separator which was standard at the time of the placement of the

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

2. Separator (continued)

contract. The following materials were checked:

Woven Teflon #T-10-42

Calendered Woven Nylon

Pellon #920 and #T-1800

Webril #430

Paper and Teflon #T-10-42

Polyvinyl Alcohol

Woven nylon Impregnated with PVA

Woven nylon coated with PVC and PVA

Paper coated with polyethylene

Non-woven polypropylene #305 POE

Based on the results of the testing described in the previous reports and on extensive tests conducted by Sonotone's Space Laboratory, the non-woven polypropylene #305POE was selected.

In addition to withstanding the environmental and other requirements of SCL-7504A, this separator has withstood 4990 cycles of charge and discharge in sealed "D" cells. The cycling was performed as in paragraph 4.4.5 of SCL-7504A as regards depth of discharge, amount of over-charge and time of both charge and discharge. Failure

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

2. Separator (continued)

was attributed to the combination of coiled core design plus the deep scoring of the cell case, causing an area of pressure at which the failure occurred.

One problem was encountered due to the selection of polypropylene. In spite of its stability at elevated temperature in cell operation, this material exhibited a marked tendency to vaporize during the welding of the collector bars to the groups of plate contact tabs. The problem was overcome by the use of metal combs which served as heat sinks for individual tabs during welding.

3. Cell Case

Stainless steel was selected as the case material due to its inertness in this type of application, eliminating the need for protective plating. Stainless steel also gives excellent non-porous welds with the heli-arc method.

The mathematical analysis described in the First Quarterly Report gave the dimensions for minimum cell weight shown in Table I.

IV. DATA AND DISCUSSION

B. Summary (continued)

3. Cell Case (continued)

Table I

Cell Type	O.D. Inches	Cylinder Ht. Inches	Overall Ht. Inches	Tube Wall Thickness	End Plate Thickness
BB440/U 10.A.H.	1.8	6.0	6.5	0.020	0.067
BB441/U 50 A.H.	3.0	8.9	9.4	0.025	0.116
BB441/U 100 A.H.	4.0	9.3	9.8	0.025	0.155

The following considerations were included in the calculations: Cross-sectional area efficiency, minimum usable tube wall thickness, head space losses, end plate thickness and maximum practical plate length.

4. Electrolyte

The electrolyte in the first prototype cells made under this contract was 1.3 sp.gr. KOH to which was added 18g./L. of LiOH. This electrolyte was added to the extent of 18% of the core weight. This has been standard electrolyte loading for sealed nickel-cadmium cells where repeated cycling is involved, but it was found to give poor results during discharge at

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

4. Electrolyte (continued)

minus 40°F. By changing to electrolyte of 1.40 sp.gr. the minus 40°F performance was improved to the extent that the low temperature requirements of SCL-7504A are easily met. (This electrolyte contains 9_g./1. of LiOH)

Improvement in low temperature performance was also sought by adding CsOH and/or RbOH to KOH and LiOH, but with negative results.

5. Terminals

Early in the development of the cell design, it was decided to locate both the positive and negative terminal on the same end. Also, to increase reliability and to decrease the possibility of accidental shorting, both terminals were insulated from the cover. To accomplish the sealing of these terminals in the cover, our standard Teflon design was planned for all 180 cells. Details of this design are shown in Figures 2 and 3. Helium leak testing of this type of seal showed a leakage rate on the order of 1 cc of gas per cell per year.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

In the Spring of 1961, Sonotone was engaged in developing a very promising method for sealing large metal terminals in a metal cell case, using metal to ceramic bonding. Since this design had been proven capable of withstanding severe vibration and shock, the contract was amended so that fifty cells each of the 50 A.H. and 100 A.H. sizes would be supplied with ceramic seals, while ten each of these two sizes along with all sixty of the 10 A.H. cells would contain the Teflon seals.

All materials for the manufacture of the ceramic sealed cells were procured and the necessary sub-assemblies were manufactured. On or about the 1st of October 1961, when the final assembly of these cells was about to take place, we were notified by one of our customers that ceramic seals identical to those planned for this contract were developing leaks after 3-4 months of use.

This design is shown in detail in Figure 4. Mechanically, this design keeps the entire assembly in compression when the proper torque is applied to the hex nut, preventing tensile and shear forces from acting on the ceramic and metal to ceramic braze joint. The actual materials used

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

in the initial seals were as described below.

The brazing alloy was Ni-Oro, a nickel-gold, selected for its resistance to KOH. The retainers were Ceramiseal, a nickel steel selected because its thermal expansion characteristics closely matched the ceramic material. The ceramic body was 94-96% alumina, and the surfaces of the ceramic to be bonded were metallized with molybdenum-manganese. This molybdenum-manganese surface was then nickel plated for bonding (actual alloying) with the Ni-Oro during the brazing operation.

Initial investigation of the failure of this seal pointed to the metallizing as the weak point, since the molybdenum-manganese proved to be the least inert of the materials involved in the presence of voltage and KOH. Therefore, most of the early efforts to correct the difficulty were directed toward using other metallizing materials, such as molybdenum-titanium, titanium, and tungsten. Also, gold plating was used to try to protect the molybdenum-manganese.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

Since none of the above attempts solved the problem, we investigated other brazing alloys with lower melting points, because the high melting point of the Ni-Oro resulted in some mismatch in thermal expansion even with the special nickel-steels such as Cerami-seal and Fernico V.
Other brazing materials included Copper, Copper-Silver, Silver, Nickel-Antimony, Gold-Antimony, Indium solders, Gold-germanium and Indium-gold.

Concurrently, we were investigating the mechanical design as a possible source of trouble. Since all the failures were observed to occur at the braze joining the inner surface of the ceramic seal to the inner retainer, it was felt that the inner brazed joint was subjected to tensile stress during the cooling following the brazing operation due to thermal expansion mismatch between the ceramic body and the nickel-steel retainer. This could cause a porous braze, an increased proclivity to corrosion or both.

The mechanical design was changed to that shown in Figure 5, which used a double tapered ceramic seal element. This retains the advantages of the previous design by preventing

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

shear and tensile forces during vibration and shock, while eliminating most of the tensile stress which could occur during the cooling after brazing.

This change did not give the desired improvement. Further investigation indicated the possibility of a porous condition in the braze. This porous condition was actually observed on samples made with Ni-Oro, which up to this point was still regarded as the most likely material due to its inertness in KOH. This porosity was observed on pieces which never had contact with KOH. A similar observation was described by Mr. Del Vecchio of the Signal Corps at the Conference of 20th July 1962.

Simultaneous efforts on ceramic seal improvements were under investigation in the Sonotone Space Laboratory where smaller cells were manufactured for a large number of satellites. Here both glass and ceramic seals had been used. Due to these efforts the final choice of braze metal was made based on what had been effective on "D" and "F" size cells. This was high grade silver, which was then incorporated in the double taper design. Six such seals were assembled in cells which have been subjected to continuous overcharge

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

since December 13, 1962, with no indication of failure. Continuous overcharging has proved to be an excellent accelerated test method for this application.

6. Vents

The resealable vents used on all the cells made under this contract are designed to release at 200 psi. The details of this vent are shown in Figure 6. Helium leak tests on these vents showed a loss of 1 cc of gas per year, and release-seal cycling shows an accuracy of ± 10%. Recently USAERDL personnel have reported slight deterioration of the neoprene "O" rings. Initial attempts to correct this condition involved the use of Teflon "O" rings, but they were unsuccessful due to the flow characteristics of the Teflon and to the seat design. However, two promising investigations are presently under way, one in which a Teflon coated neoprene "O" ring, and the other in which Teflon compositions of different flow characteristics are being checked for use in our present design. All cells shipped contain the neoprene "O" rings in the vents.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

7. Environmental Testing

During the environmental testing required by SCL-7504A, the only problem encountered occurred during the vibration testing of the 100 A.H. cells. While performing the qualification test in October 1962, all 8 cells under test failed to survive the vibration.

Failure was caused by the breaking of approximately 50% of the individual plate contact tabs - the result of motion of the heavy cores during vibration in the longitudinal axis. To further immobilize the core, the walls of the cylinders were partially scored. The scoring tool was designed to indent the cell container only at points where the effect would be to exert pressure perpendicular to the face of the plates and stack-ups. Care was taken to avoid damage to the plate and stack-up edges. The scoring was done on fifty each of the 100 A.H. and 50 A.H. cells, and not on the cells delivered on October 17, 1961 or November 28, 1961.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests

All the qualification tests performed on the BB440, BB441 and BB442 "teflon and ceramic" cells were performed in accordance with SCL-7504A. In a few instances, it was necessary to change the test procedures in order to meet the time allowed for the use of the environmental test equipment. USAERDL approval was obtained before any of these changes were made.

The sixteen (16) cells of each size, designated by SCL-7504A to receive the qualification tests, were numbered 1 to 16. These qualification numbers correspond to the serial numbers of each type in the following manner:

Qual. No.	Serial Number BB440 (10 AH)	BB441 (50 AH)	BB442 (100 AH) Teflon	BB442 (100 AH) Ceramic
1	00058	38	11	45
2	00047	53	13	46
3	00023	34	15	47
4	00035	47	17	48
5	00055	11	19	49
6	00039	50	21	50
7	00015	28	23	51
8	00016	45	25	52

Qual. No.	Serial Number BB440 (10 AH)	BB441 (50 AH)	BB442 (100 AH) Teflon	BB442 (100 AH) Ceramic
9	00052	18	27	53
10	00056	58	29	54
11	00021	21	31	55
12	00020	43	33	56
13	00014	17	35	57
14	00038	31	37	58
15	00048	13	39	59
16	00044	35	41	60

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

Test Procedure as Per SCL-7504A:

1) Inspection as per Paragraph 4.3

Cells #1-16 of each size were inspected for evidence of electrolyte leakage on the external surfaces. The weight of each cell was also recorded.

Comment:
There were no indications of electrolyte leakage on any of the external surfaces.

2) Full Capacity Discharge as per Paragraph 4.4.2.1

Cells #1-16 were charged in accordance with paragraph 4.4.1 ($.2C_5$ rate - 8 hours). After a minimum stand of 30 minutes between charge and discharge all the cells were discharged at the $.2C_5$ rate. The minimum specified discharge time to the 1.0 volt end point is 300 minutes.

Comment:
All test cells met the capacity requirements of the specification. Refer to Tables II, III, IV and V for individual cell performance.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

3) High Rate Discharge as per Paragraph 4.4.4

Cells #1-16 were charged as per paragraph 4.4.1. Cells 1-8 were discharged at the $3C_5$ rate and cells 9-16 were discharged at the $.2C_5$ rate. The discharge time and voltage requirements are as follows:

Disch.Rate	Minimum Time to 1.0V	Minimum 5 Sec.Disch. Volt
$3C_5$	15 min.	1.15 volt
$.2C_5$	300 min.	No requirement

Comment:
All test cells met the requirements of the specification. Refer to Tables II, III, IV and V for discharge performance of the individual cells.

4) Low Temperature Test as per Paragraph 4.4.3

Cells #1-16 were charged as per paragraph 4.4.1. Cells #1-4 and #9-12 were placed in a cold chamber at -40°F and allowed to stabilize for at least 24 hours at this temperature. A discharge was then performed at the $.2C_5$ rate. The minimum specified time to the 1.0 volt end point is 150 minutes. Cells #5-8 and #13-16 were discharged at room temperature at the $.2C_5$ rate. The minimum specified time to the 1.0 volt end point is 300 minutes.

Comment:
All cells met capacity requirements during this test. Refer to Tables II, III, IV and V for individual cell performance.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

5) Temperature Shock as per Paragraph 4.5.1 (In accordance with MIL-STD-202 Method 102A, Condition D)

Cells #1,2, 5,6, 9,10, 13, and 14 were used for the temperature shock requirements. The cells were in a discharged condition during the test. The temperature cycle was repeated five (5) times and is as follows:

30 minute stand at -44°C; 10-15 minute stand at room temp.

30 minute stand at +85°C; 10-15 minute stand at room temp.

Comment:
All cells met the specification requirements during and after the completion of the test.

6) Vibration (low and high frequency) as per Paragraph 4.5.5 and 4.5.6

Cells #1-16 were charged as per Paragraph 4.4.1. Cells 1,2, 5,6, 9,10, 13,14 were used for the vibration test. The remaining cells were used as controls and discharged at the $.2C_5$ rate at room temperature.

The following vibration cycle was performed in each of three planes, one plane being perpendicular to the cell cover, and the other two planes being parallel to the cell cover and perpendicular to each other. Also, one of these latter planes was perpendicular to the plates.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

Vibration Cycle:	Low Frequency	High Frequency In Accordance with (MIL-STD-202A Sec.C Part 2)
Freq. Range	10-55-10 cps	55 - 2000 cps
Excursion	.06" double amplitude	-
Acceleration	-	10g
Scanning Rate	1 cycle/sec./minute	3 degrees/min.
Total Scanning Time	90-100 minutes	35 ± 5 minutes
Tests Performed*	O.C.V. monitored	$.2C_5$ discharge

Comment:
There were no voltage interruptions or capacity failures on any of the three types of cells. The $.2C_5$ discharge rate was continued at the completion of the vibration tests and the total discharge time to the 1.0V end point is taken as the accumulated time during and after vibration. The minimum specified time to 1.0 volt is 300 minutes. Refer to Tables II, III, IV and V for the individual cell performance of the vibrated and non-vibrated cells.

* In order to complete the tests in the time alloted for the vibration, it was necessary, in some instances, to perform the $.2C_5$ discharge during the low frequency vibration. USAERDL approval was obtained for this additional discharge.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

Shock, Acceleration and Altitude as per Paragraph 4.5.2, 4.5.3, 4.5.4

Cells #1-16 were charged at the .2C_5 rate. The odd numbered cells (1, 3, 5, 7, 9, 11, 13, 15) were used for the Shock, Acceleration and Altitude tests. The even numbered cells (2, 4, 6, 8, 10, 12, 14, 16) performed as controls and were discharged at room temperature at the .2C_5 rate to the specified end point.

Shock:
Each cell was subjected to three mutually perpendicular shocks of equal magnitude. For each shock the cell was accelerated in such a manner that during the first 3 milliseconds the minimum average acceleration was 75 g's. The open circuit voltage of each cell was monitored during each shock plane.

Comment:
There were no voltage interruptions observed in any of the cells during any part of the shock test.

Acceleration:
The cells were subjected to an acceleration of 60 g's in both directions along an axis perpendicular to the top and bottom of the cell, and in one direction along each of the other two mutually perpendicular axes. Each period of the acceleration was for a duration of 5 minutes. The total acceleration time was 20 minutes.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

7) (continued)

Comment:
During the testing of the BB442 (100 A.H. "teflon" cells) the acceleration fixture failed and four (4) of the cells were damaged. Although the damage will prevent the final acceptance of these particular cells, they continued along in the remaining phases of the test program meeting capacity requirements. (Refer to section discussing extent of cell damage).

The $.2C_5$ rate discharge was performed on the BB440 (10 A.H.) cells during each of the 5 minute acceleration periods. The discharge was then continued in the altitude test. This extra test was performed with USAERDL approval.

Elevation:
On completion of the acceleration tests the eight (8) cells were placed in an altitude chamber in an upright position. The barometric pressure was reduced to simulate an altitude of 120,000 feet above sea level (3.5 mm Hg) and a discharge at the $.2C_5$ rate was performed. The altitude conditions were maintained until the specified cutoff voltage was reached. The minimum specified time to 1.0 volt is 300 minutes.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

7) (continued)

Comment:
All the cells met the capacity requirements during the altitude test. Refer to Tables II, III, IV, and V for the individual cell performance.

8) Full Capacity Discharge as per Paragraph 4.4.2.1

On the completion of all the environmental and temperature tests, the sixteen (16) cells were charged at the .2C_5 rate and dischargedat the .2C_5 rate at room temperature. The minimum specified time to the 1.0 volt end point is 300 minutes.

Comment:
All cells met capacity requirements during this final test. Refer to Tables II, III, IV and V for individual cell performance.

9) Inspection as per Paragraph 4.3

Each of the sixteen (16) qualification cells was inspected for indications of electrolyte leakage around the seals, vents and heliarc welds, and the weight of each cell was compared with the weight taken prior to the start of the qualification test. Average performance during the qualification tests is summarized in the discharge curves, figures 7, 8 and 9.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

9) (continued)

Comment:
Except for the four (4) BB442 "teflon" cells damaged during acceleration by failure of the fixture, there were no indications of external damage or electrolyte leakage around the terminal seals or heliarc welds, nor any loss in weight on any of the sixteen (16) cells of each type tested.

Two of the four cells damaged by the acceleration fixture failure appear to be perfectly functional. Due to the extent of the denting and gouging of the cell case material (Figure 10), there is possibility of core damage. The other two damaged cells are no longer sealed, since the terminals were driven into the cover, destroying the teflon seal (Figure 11). All four cells have been replaced with new cells containing ceramic seals, using the original serial numbers (11, 27, 35, 39).

Test Locations and Witnesses:

BB440/U Cells (10 A.H.)
All electrical and temperature tests were performed at Sonotone. All environmental tests were performed at York Research, Stamford, Conn., witnessed by Mrs. Sylvia Duze of USAERDL.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

9) (continued)

BB441/U Cells (50 A.H.)
All electrical, temperature and vibration tests were performed at Sonotone. (Vibration witnessed by Mrs. Sylvia Duze). All remaining environmental tests performed at York Research, Stamford, Conn. (Witnessed by Mrs. Sylvia Duze).

BB442/U Cells (100 A.H. Teflon and Ceramic)
All electrical and temperature tests performed at Sonotone. All environmental tests performed at General Precision Labs., Pleasantville, N. Y. There was no USAERDL witness present. We are attaching an affidavit from General Precision Labs covering the environmental testing. (See Exhibit I).

V. OVERALL CONCLUSIONS

1. Large sealed nickel-cadmium cells can be manufactured incorporating all of the advantages of the more conventional sizes.

2. Based on the minus 40°F data, these large cells have superior low temperature discharge characteristics to the usual size cells.

3. Since no abnormal behavior was exhibited by the 100 A.H. capacity cell, this does not appear to be the maximum in size and capacity for this design.

4. The requirements of SCL-7504A are realistic.

VI. RECOMMENDATIONS

1. The cells delivered under this contract should be checked for conformance to the design objectives of SCL-7504A regarding life cycling and storage.

2. The excellent low temperature performance of these cells should be further explored.

3. When these cells are connected in series, the metal cell cases should be electrically insulated from each other, and the hardware shown in Figure 12 should be used. When fastening the intercell connectors, torque should not exceed 50 inch pounds on the teflon sealed terminals, and 30 inch pounds on the ceramic sealed terminals.

4. Work should be done on improving the overcharge and heat dissipation characteristics of these cells, the aim being ultimate use of this type of cell in vehicles or other applications where the charging is done by constant potential devices.

5. Adapt recent developments in Sonotone satellite cells for use in these large cells, e.g.

   New separators

   New Plaque loading techniques

   New ceramic sealing techniques.

VII. PERSONNEL

Listed below are the personnel who worked on the contract for a total of over 200 hours, together with the total number of hours spent by the Design Engineering Group and by the Battery Improvement Laboratory.

Design Engineering

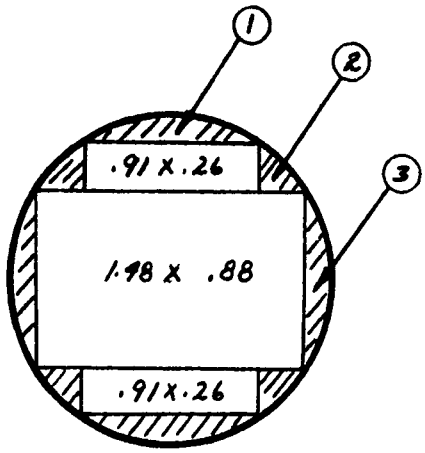
Name	Title	Hours
J. Herrmann	Environmental Test Engineer	200
H. Bilsky	Supervisory Engineer	520
I. Michalko	Des. Engineer	2100
I. Goldstein	Des. Engineer	850
G. Lanni	Machinist	530
M. Legman	Machinist	230
Others		870
	Design Engineering Total	5300

Battery Improvement Laboratory

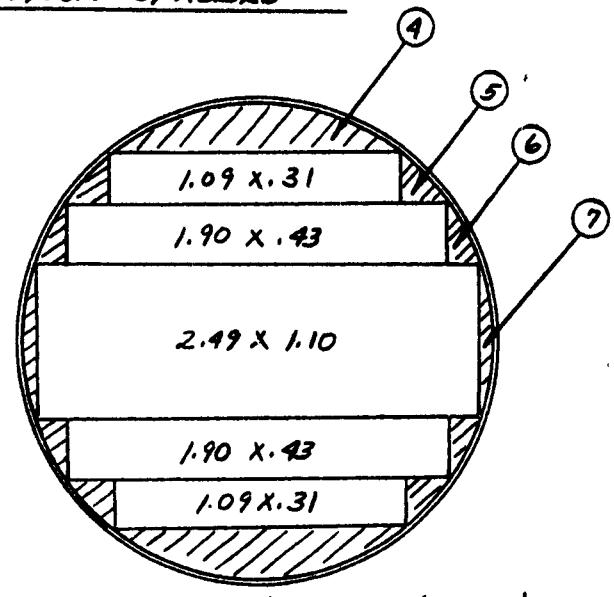
F. Alliegro	Supervisory Engineer	860
W. Ryan	Administration	205
R. McCormick	Assoc. Engineer	2100
J. Perez	Engineer	310
D. Volpe	Technician	300
J. Spiteri	Technician	260
Others		1165
	Battery Improvement Lab. Total	5200
Combined Total		10,500

The above does not include production personnel.

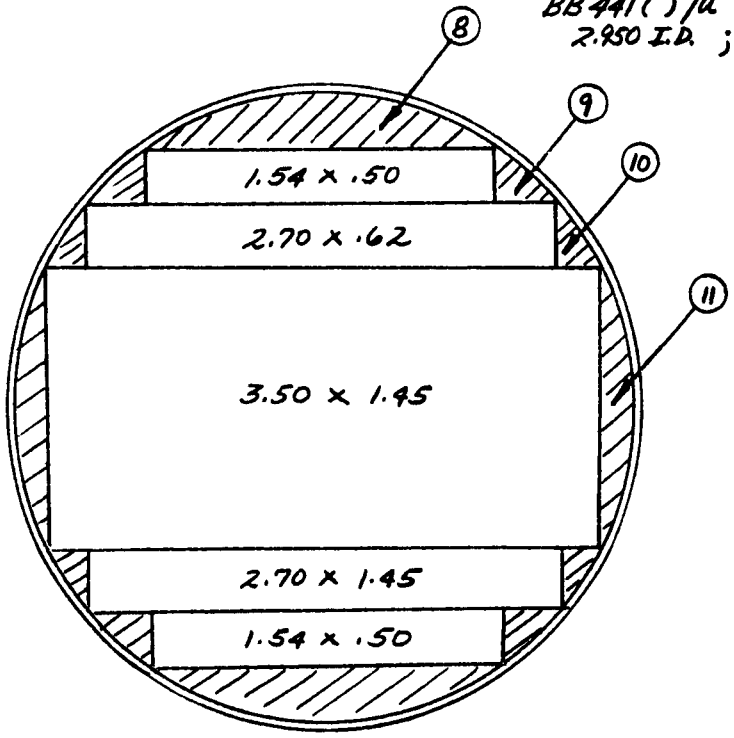
CROSS SECTION DIMENSIONS OF CYLINDRICAL CELLS AND LOCATION OF NYLON SPACERS



BB440( )/U CELL (10 A.H.)
1.773 I.D. ; .020 WALL



BB441( )/U CELL (50 A.H.)
2.950 I.D. ; .025 WALL



BB442( )/U CELL (100 A.H.)
3.950 I.D ; .025 WALL

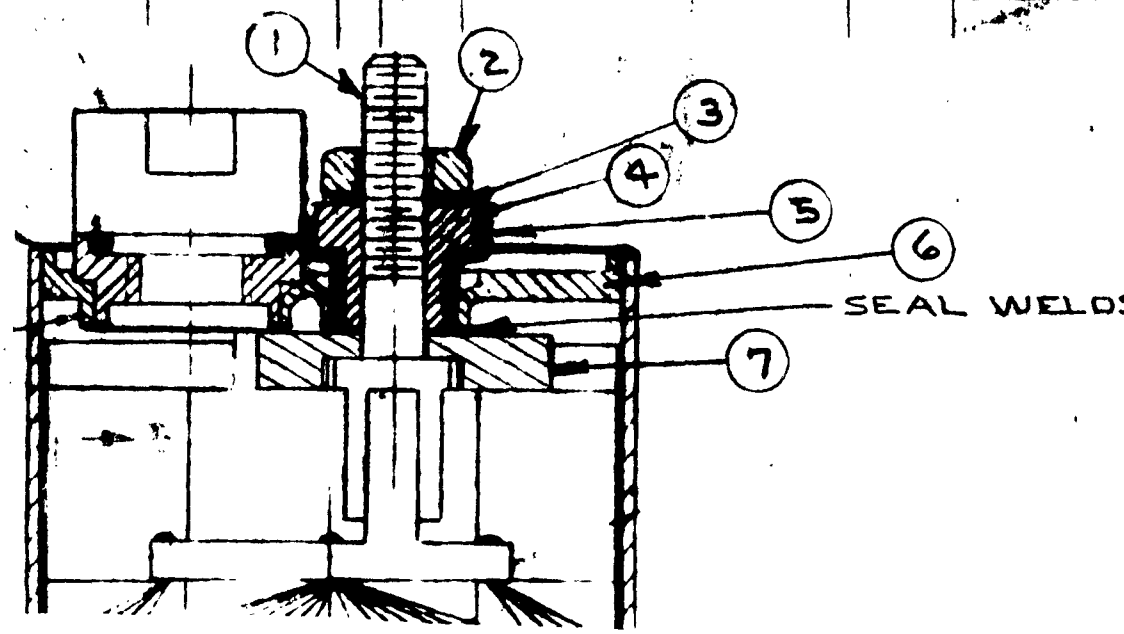
NYLON SPACERS

	NYLON SPACER PART NUMBER
1	Y 24266 -2
2	Y 24267 -1
3	Y-24266 -1
4	Z 24592 -1
5	Z 24591 -1
6	Z 24591 -2
7	Z 24592 -2
8	Z 24595 -1
9	Z 24594 -1
10	Z 24594 -2
11	Z 24595 -2

FIG. 1

FIG. 2

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	SYMBOL	DESCRIPTION	DATE	APPROVAL



1- TERMINAL

2- NUT

3- FLAT WASHER - STAINLESS STEEL

4- TEFLON SEAL

5- RETAINER - STAINLESS STEEL

6- COVER - STAINLESS STEEL

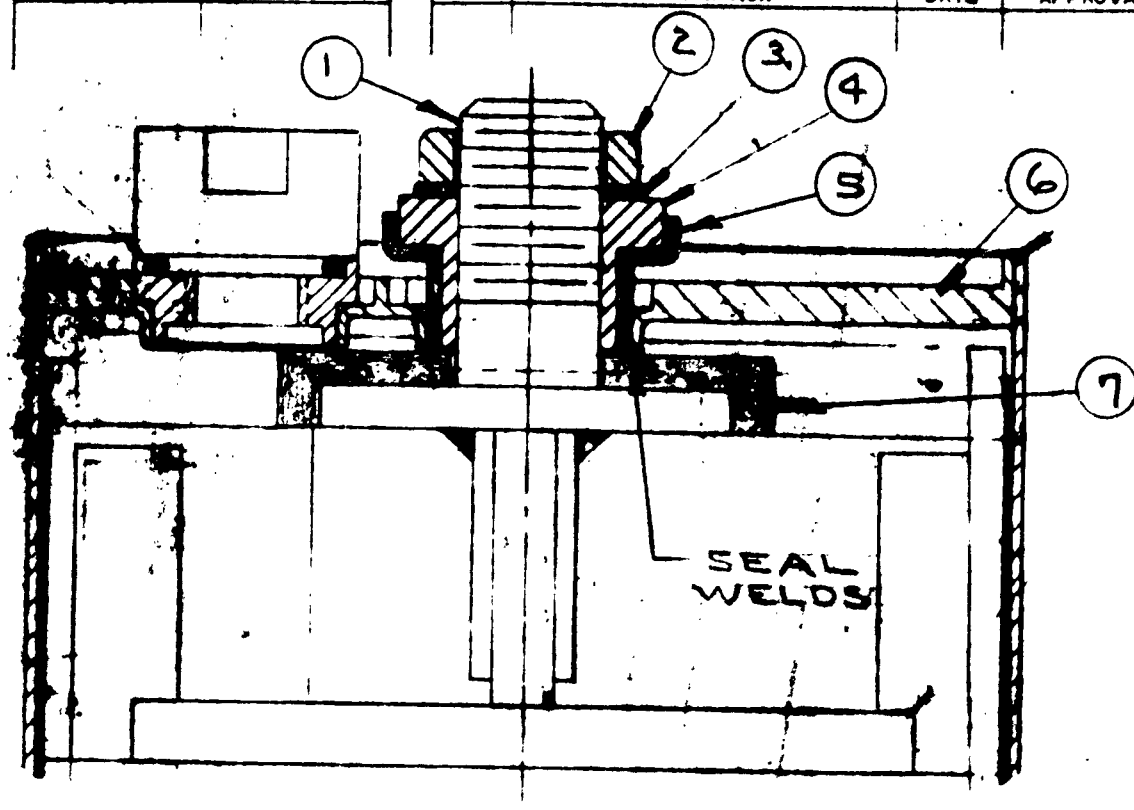
7- INTERIOR TERMINAL WASHER - TEFLON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON			SIGNATURES	DATE	TITLE	SONOTONE CORP. ELMSFORD, N. Y.
FRACTIONS	DECIMALS	ANGLES	DRAWN		TEFLON SEAL 10 A.H.	
±1/64	±.010	±0°30'	CHECKED			
APPLICABLE SPEC.			APPROVED			
SPEC.			APPROVED			
FIN. SPEC.			APPROVED			
PROC. SPEC.			APPROVED			
SEAL SPEC.			APPROVED			

SCALE	DWG SIZE	FIG. 2	REV.
DO NOT SCALE DRAWING	A	SHEET OF	

FIG. 3

REV	APPLICATION		REVISIONS			
	NEXT ASSY	USED ON	SYMBOL	DESCRIPTION	DATE	APPROVAL



1- TERMINAL

2- NUT

3- FLAT WASHER - STAINLESS STEEL

4- TEFLON SEAL

5- RETAINER - STAINLESS STEEL

6- COVER - STAINLESS STEEL

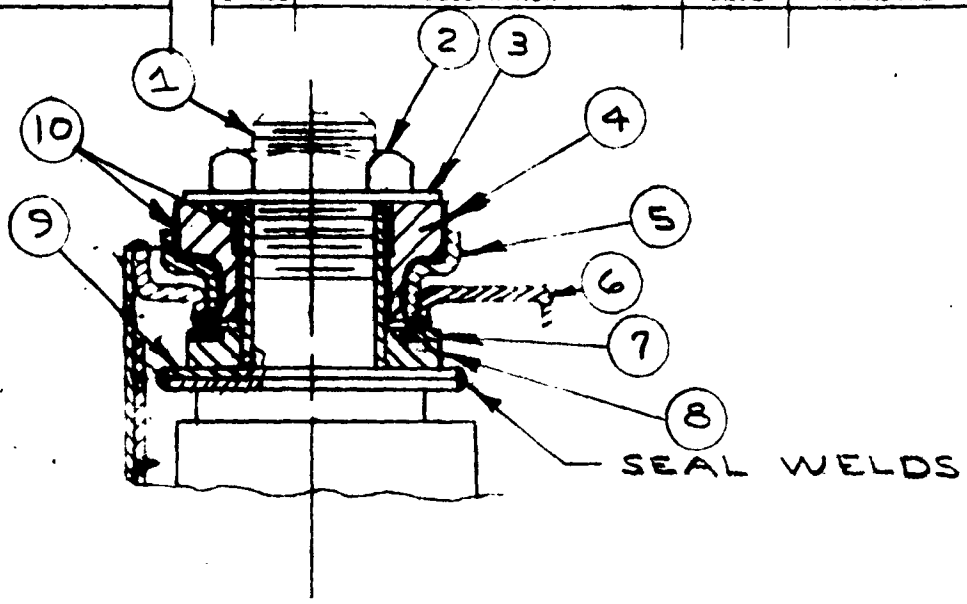
7- INTERIOR TERMINAL WASHER - TEFLON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON			SIGNATURES	DATE	TITLE	
FRACTIONS ±1/64	DECIMALS ±.010	ANGLES ±0°30'	DESIGNER		TEFLON SEAL S.O.A.H.	SONOTONE CORP. ELMSFORD, N. Y.
APPLICABLE SPEC.			DRAFTSMAN			
MAT. SPEC.			CHECKER			
FIN. SPEC.			APPROVED			
PROC. SPEC.			APPROVED			
QUAL. SPEC.			APPROVED			
			APPROVED			

SCALE	DWG SIZE	FIG. 3	REV.
DO NOT SCALE DRAWING	A	SHEET OF	

FIG. 4

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	SYMBOL	DESCRIPTION	DATE	APPROVAL



1- TERMINAL

2- NUT

3- BELLEVILLE SPRING WASHER

4- CERAMIC SEAL

5- CERAMI-SEAL RETAINER-OUTER

6- COVER - STAINLESS STEEL

7- WELL BEARING WASHER

8- CERAMIC SPACER

9- CERAMI-SEAL RETAINER - INNER

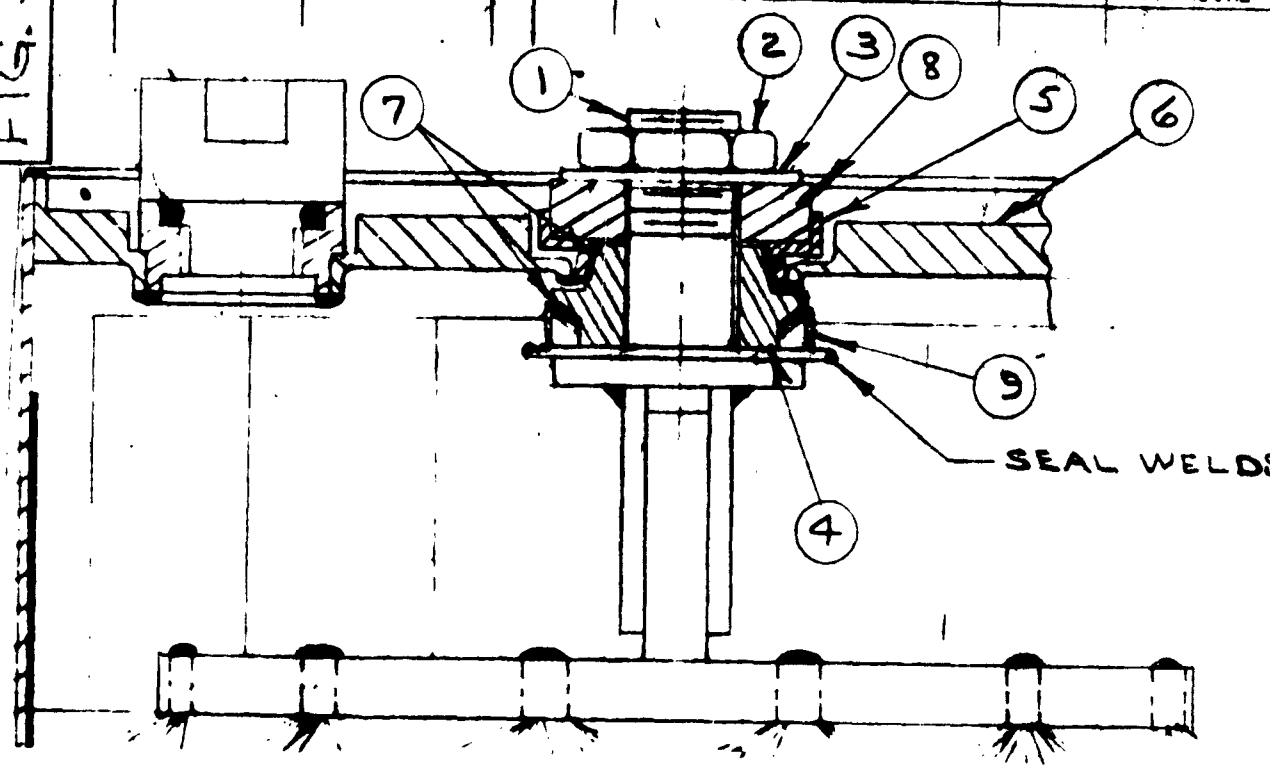
10- BRAZE MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON			SIGNATURES	DATE	TITLE	
FRACTIONS	DECIMALS	ANGLES	DESIGNER		CERAMIC SEAL I.D. & O.D.	SONOTONE CORP. ELMSFORD, N. Y.
±1/64	±010	±0°30	DRAFTSMAN			
APPLICABLE SPEC.			CHECKER			
MAT. SPEC.			APPROVED			
			APPROVED			
FIN. SPEC.			APPROVED			
PROC. SPEC.			APPROVED			
QUAL. SPEC.			APPROVED			

SCALE	DWG SIZE	FIG. 4	REV.
DO NOT SCALE DRAWING	A	SHEET	

FIG. 5

REV	APPLICATION		REVISIONS			
	NEXT ASSY	USED ON	SYMBOL	DESCRIPTION	DATE	APPROVAL



1- TERMINAL

2- NUT

3- BELLEVILLE SPRING WASHER

4- CERAMIC SEAL - DOUBLE TAPER

5- BUSHING - OUTER - CERAMIC SEAL

6- COVER - STAINLESS STEEL

7- BASE MATERIAL

8- CERAMIC SPACER

9- TERMINAL - BOTTOM - CERAMIC SEAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON FRACTIONS DECIMALS ANGLES ±1/64 .010 ±0°30	SIGNATURES	DATE	TITLE	SONOTONE CORP. ELMSFORD, N. Y.
APPLICABLE SPEC.	DESIGNER		CERAMIC SEAL DOUBLE TAPER	
SPEC.	DRAFTSMAN			
	CHECKER			
	APPROVED			
FIN. SPEC.	APPROVED			
PROC. SPEC.	APPROVED			
QUAL. SPEC.	APPROVED			
	SCALE: DO NOT SCALE DRAWING		DWG SIZE: A	FIG. 5 SHEET OF REV.

SONOTONE CORP. ELMSFORD, N. Y.

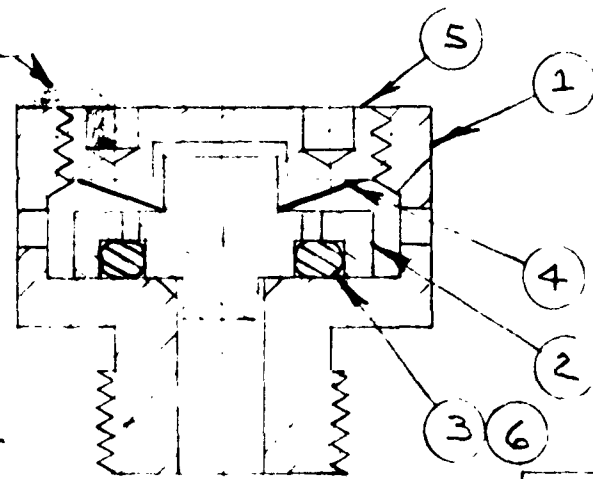
DRAWING & ISSUE NO. Z-22355 1 2

DESCRIPTION VALVE ASST - VENT

SCALE 4X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	VALVE BODY	T22356					1
2	"O" RING RETAINER	T22357					1
3	"O" RING	T10343 IT.16					1
4	BELLEVILLE SPRING	T16128 IT.20					1
5	VALVE SCREW	Z22358					1
6	SILICONE GREASE - HIGH VACUUM		MS20019 IT.16				AS REQ
7	CEMENT		MS20007 IT.19				AS REQ

SEE NOTE 3



1-COAT IT.3 WITH IT.6. USE GREASE SPARINGLY.

2-CALIBRATE TO RELEASE PRESSURE OF 200±10 PSIG.

3-AFTER CALIBRATING PLACE CEMENT IT.7 AS SHOWN.

ASSY	RELEASE PRESSURE
1	200 ± 10
2	100 ± 10

R-1386	R-1384
R-1385	W-24240
	W-24250
	X-24260
	PL1279
	X-22340
	ASSEMBLIES USED ON

IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

Z22355	DRAWN BY: 10/29/62	CHECKED BY:	ENG. APPROVAL	RES. APPROVAL	CHANGES	ADD ASSY 2 11/21/62

FIG. 6

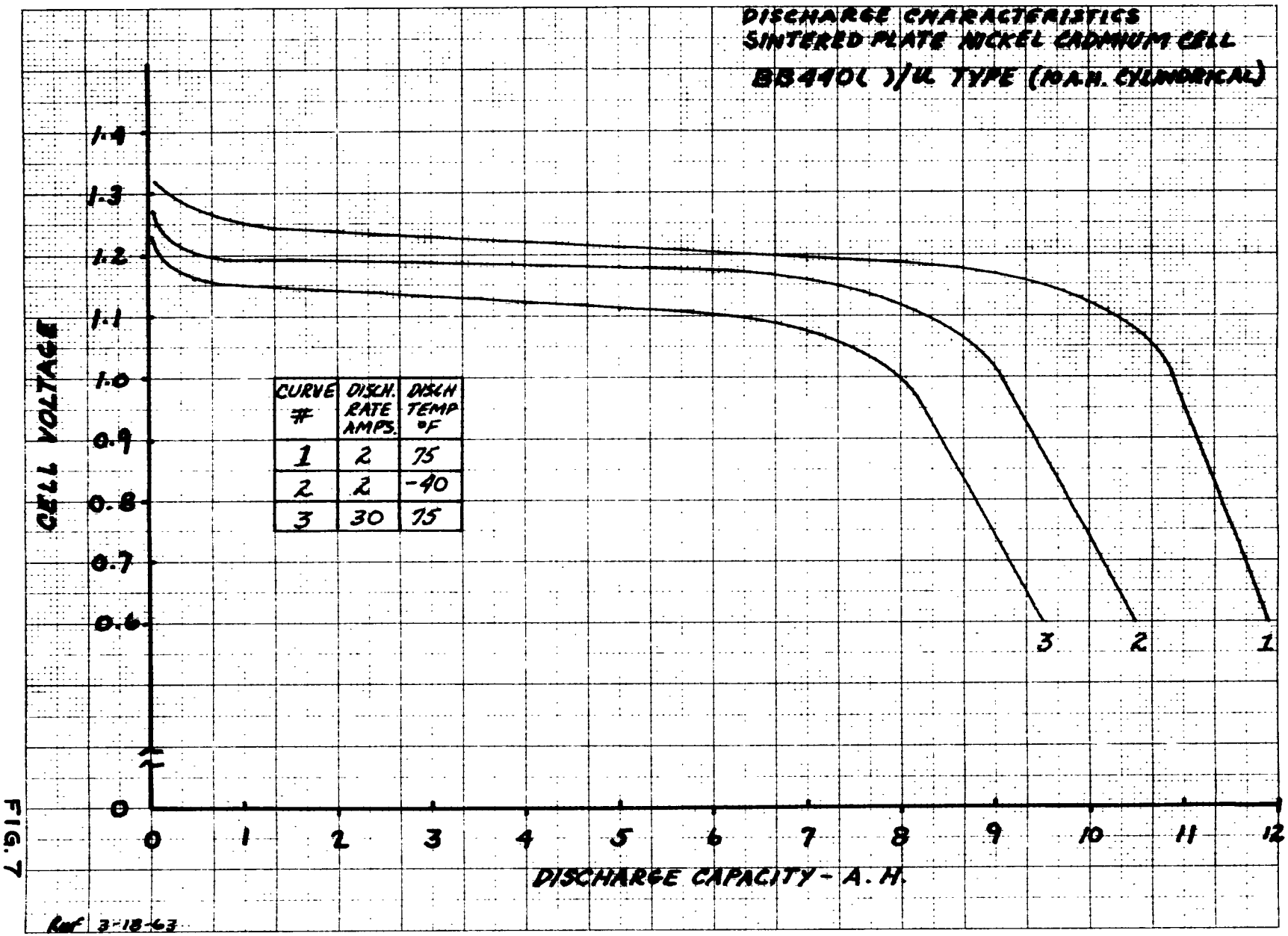


FIG. 7

Ref 3-18-63

1.29

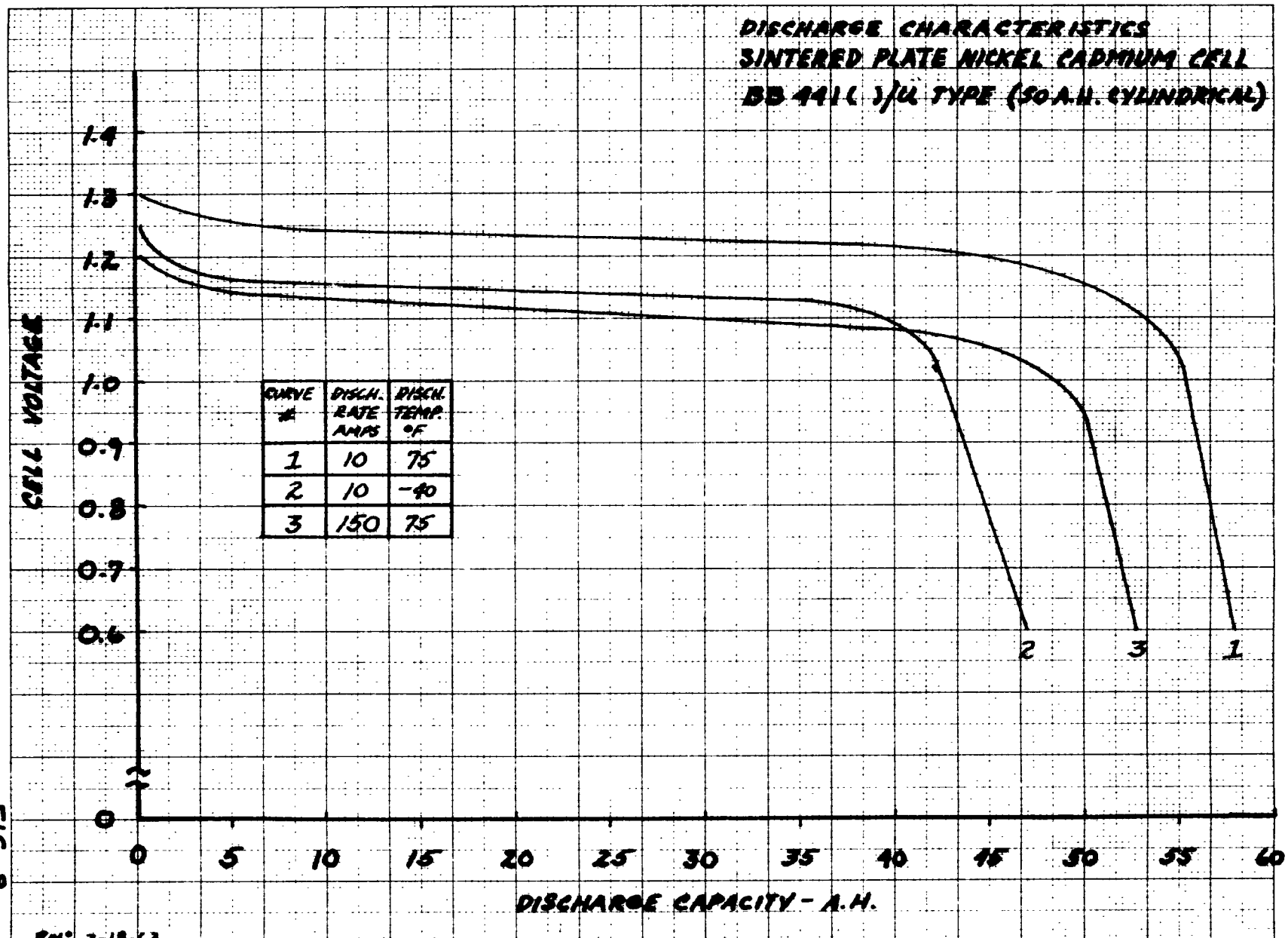


FIG. 8

Rev° 3-18-63

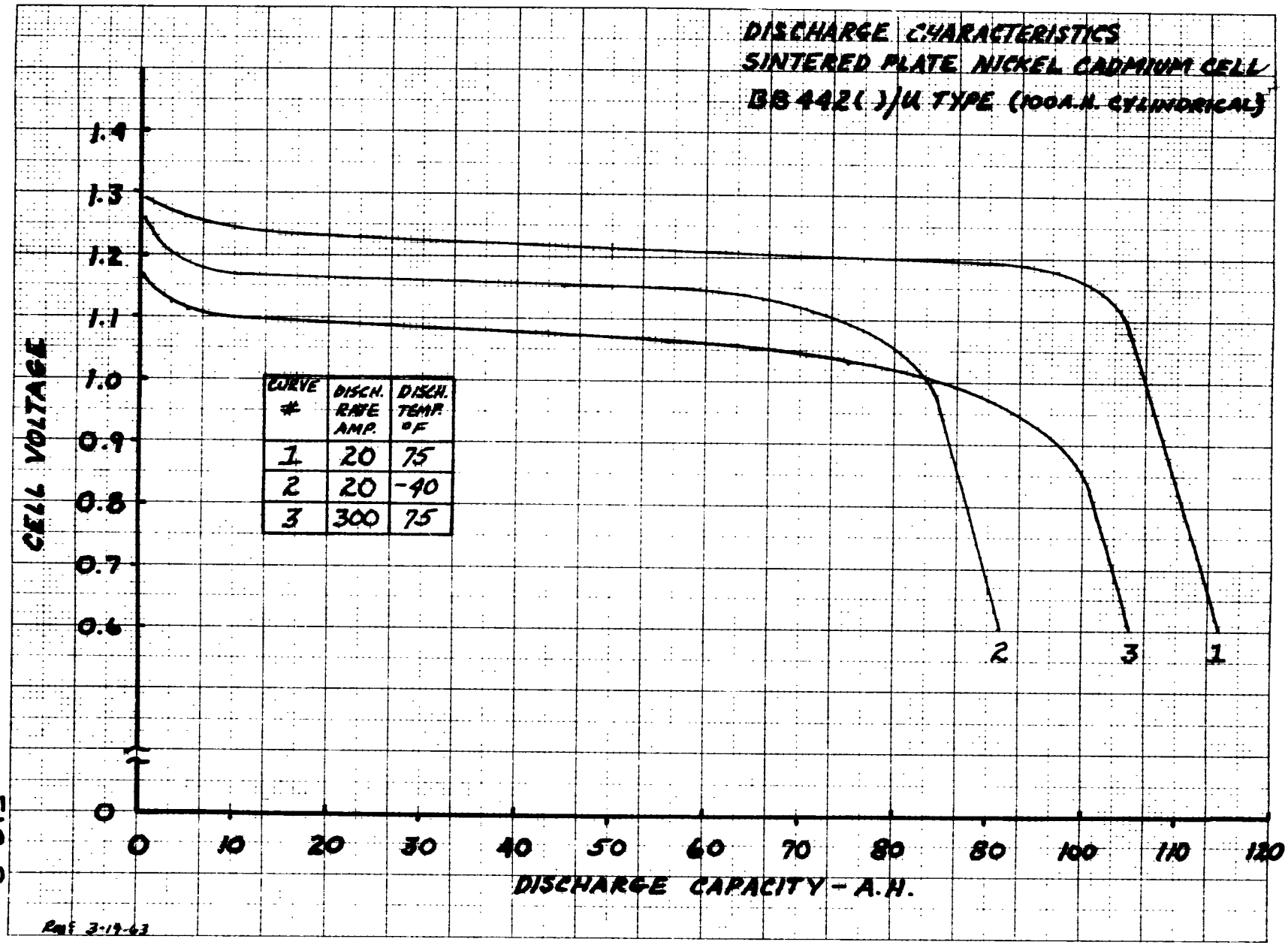
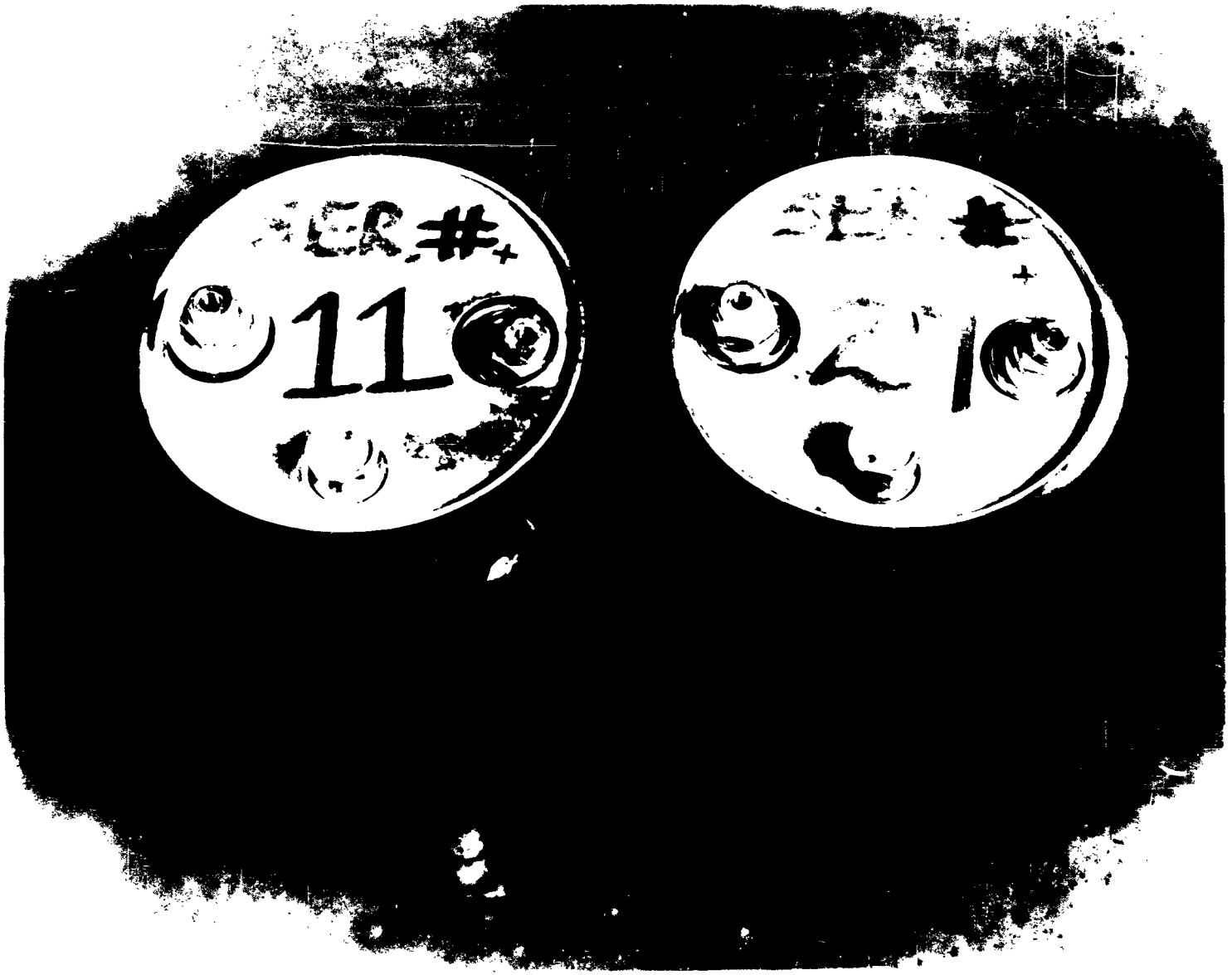


FIG. 9

Rev. 3-19-63


ER #
11

QUALIFICATION TEST BB440( )/U CELL AS PER SCL 7504A
(10 A.H. CYLINDRICAL CELL)

	SERIAL NUMBER		00058	00047	00023	00035	00035	00039	00015	00016	00152	00056	00027	0002[illegible]	00014	00038	00048	00044
	QUAL. TEST NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	TEST DESCRIPTION																	
1.	INSPECTION	MIN. TO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.	DISCH. .2C_5 RATE (2 AMPERES)	1.0V	400.2	400.4	404.7	395.3	391.7	399.7	408.2	403.4	408.4	401.2	385.1	376.9	390.4	413.6	391.3	402.3
		0.6V	406.3	412.4	413.6	410.5	408.3	409.4	417.3	410.6	414.7	407.4	401.4	385.2	401.6	422.7	408.4	407.7
3.	DISCH. .2C_5 RATE	1.0V	389.1	391	386.7	381.6	379	386.1	390.3	387								
		0.6V	396.2	400.2	393.7	390.1	388	394.5	400.4	394.6								
	DISCH. 3C_5 RATE (30 AMPERES)	5 SEC. VOLT.									1.22	1.22	1.23	1.22	1.21	1.22	1.22	1.21
		1.0V									15.8	17.2	16.5	16.1	15.9	17.2	15.7	16
		0.6V									17.6	20.6	19.4	19.7	19.1	20.6	18.3	19.2
4.	DISCH. .2C_5 RATE	1.0V					347	344.3	343	341.6					342.8	341.7	344.3	340.1
		0.6V					359.4	360.2	381.4	369.6					352.2	353	358.6	351
	DISCH. .2C_5 RATE (-40°F)	1.0V	285.5	252.1	264.6	297					267.8	311.4	270.1	264.9				
		0.6V	311.1	285.6	297.2	320					321	326	311.4	312				
5.	TEMP. SHOCK	NO DISCH.	✓	✓			✓	✓			✓	✓			✓	✓		
6.	DISCH. .2C_5 RATE	1.0V			327	329			338.5	343.7			328	330.8			325	322.5
		0.6V			349	357			375.1	384.9			366.7	353.4			355.6	356.6
	DISCH. .2C_5 RATE (VIBRATION)	1.0V	308.6	304.6			304.6	307.7			322.6	322.6			321.6	306.8		
		0.6V	322.7	313.5			324.2	320.9			339.7	327.3			331.5	313.4		
7. *	DISCH. .2C_5 RATE	1.0V		307.2		340.1		310.5		338.6		327.6		321.5		317.6		328.3
		0.6V		343.5		368.7		341.4		371.1		357.3		360.[illegible]		348.1		368.8
	DISCH. .2C_5 RATE (SHOCK, ACCEL. & ALTITUDE)	1.0V	343.4		339.7		343.1		325.5		353.9		345.6		343.9		356.9	
		0.6V	351		353.4		365		346.5		363.3		363.8		354		366.3	
8.	DISCH. .2C_5 RATE	1.0V	321.4	322.3	302.6	334.3	301.9	319.7	321.1	333.5	324.1	344.3	320.7	324.5	323.2	321.8	319.8	324.9
		0.6V	344.6	345.6	344.3	361.8	340.2	357.1	359.3	363.4	354.3	356.5	350.7	358.3	351	354.7	345.1	361.1
9.	INSPECTION		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE II

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* NO DISCH. DURING SHOCK; 88 HR. STAND AT 0°F BETWEEN ACCEL. & ALTITUDE TESTS.

QUALIFICATION TEST BB441( )/U CELL AS PER SCL 7504A
(50 A.H. CYLINDRICAL CELL)

	SERIAL NUMBER		38	53	34	47	11	50	28	45	18	58	21	43	17	31	13	35
	QUAL. TEST NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	TEST DESCRIPTION																	
1.	INSPECTION	MIN TO	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.	DISCH. .2C_5 RATE (10 AMPERES)	1.0V	317.1	323	317.8	315.8	315.8	310	318	311.8	316	313.5	314.4	32 8	31 8	321.5	319.5	319
		0.6V	339.5	343.4	343	337.8	333	334.5	338.4	330.5	333.7	330.7	334	3 9	3 8	340	338	340.5
3.	DISCH. .2C_5 RATE	1.0V									350.7	338.5	348.3	3 9	355.8	345.2	350.5	344.1
		0.6V									365.2	357.4	367	36 7	372.2	373.4	365	368.8
	DISCH. 3C_5 RATE (150 AMPERES)	5 SEC. VOLT.	1.22	1.20	1.20*	1.20	1.20	1.19	1.20	1.185								
		1.0V	19.9	20	19.9	19.5	19.2	18.5	19.2	18.2								
		0.6V	22	22.3	21.8	21.5	20.9	20.6	21.1	20.3								
4.	DISCH. .2C_5 RATE	1.0V					357.5	356.2	361.5	360					356	356	359	352
		0.6V					371.9	377.2	377.1	371.7					376	383	374	383
	DISCH. .2C_5 RATE (-40°F)	1.0V	236.7	251.7	259.7	263.4					254	254.5	265.7	261.6				
		0.6V	256.6	273.1	281.6	277.3					285	287.4	298.1	294.6				
5.	TEMP. SHOCK	NO DISCH.	✓	✓			✓	✓			✓	✓			✓	✓		
6.	DISCH. .2C_5 RATE	1.0V			345.5	338.5			357	350.5			330	335			353.4	356.8
		0.6V			360	358.5			369.5	360.2			350	351.4			364	376
	DISCH. .2C_5 RATE (VIBRATION)	1.0V	316.5	331			333.8	337			314	302.4			333	319.5		
		0.6V	323.2	337			340.5	345			318	307			342	331		
7.	DISCH. .2C_5 RATE	1.0V		336.6		333		316.1		321.3		332.5		333.7		320		330.6
		0.6V		345.6		340.7		327.4		329		339		33 9		329.8		339.5
	SHOCK & ACCEL.	NO DISCH.	✓		✓		✓		✓		✓		✓		✓		✓	
	DISCH. .2C_5 RATE (ALTITUDE)	1.0V	313.4		321.6		303.8		318.6		308		328.1		301.5		312.5	
		0.6V	323.3		336.8		312.4		334.1		319.1		339.3		309.1		327.4	
8.	DISCH. .2C_5 RATE	1.0V	314	328	320.2	319.6	305	315.8	305	304.7	315.9	331	316	325.5	319	320	306	323.5
		0.6V	337	353	341.6	337.1	322	337.3	313	321.4	332.1	343.2	330.1	340.6	329.1	331.6	319	341.4
9.	INSPECTION		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE III

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QUALIFICATION TEST BB442( )/U CELL AS PER SCL 7504A
(100 A.H. CYLINDRICAL CELL WITH TEFLON SEALS)

SERIAL NUMBER			11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41
QUAL. TEST NUMBER			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
TEST DESCRIPTION			*								*				*		*	
1.	INSPECTION	MAN. HR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.	DISCH. .2C_5 RATE (20 AMPERES)	1.0v	341.7	342.4	344.1	355	333.8	337.4	353.3	337.6	335.5	342	339.4	342.4	339.6	338.9	339.6	333.4
		0.6v	358.9	360.8	361.1	369.3	355.1	357.2	368.1	355.6	359.2	355.7	356	356.3	356.3	356	353.8	349.
3.	DISCH. .2C_5 RATE	1.0v									328.5	336	326.9	329.2	329.1	329.5	332	325
		0.6v									356.5	362.7	356.5	355.3	356	353	359.7	354.5
	DISCH. 3C_5 RATE (300 AMPERES)	5 SEC VOLT	1.16	1.16	1.155	1.155	1.16	1.16	1.155	1.16								
		1.0v	17.5	17.7	17	18.3	15.7	15.4	17	16.3								
		0.6v	22.4	22.4	21.3	21.4	21	20.4	21	20.6								
4	DISCH. .2C_5 RATE	1.0v					317.4	318	322.5	322.5					308	306.1	308	307.5
		0.6v					323.6	323	331.7	331.7					316	315.4	317	319
	DISCH. .2C_5 RATE (-40°F)	1.0v	252.3	249.2	252	289.5					248.7	245	246.5	244				
		0.6v	274.5	273	272.5	301.3					269.5	267	268	267.5				
5.	TEMP. SHOCK	NO DISCH	✓	✓			✓	✓			✓	✓			✓	✓		
6.	DISCH. .2C_5 RATE	1.0v			312	341			336	330			306	310			321	321
		0.6v			316	344			339	333			312	315			326	327
	DISCH. .2C_5 RATE (VIBRATION)	1.0v	314.1	311.3			311.5	311.5			303.3	308.7			310.2	310.2		
		0.6v	320.2	315.9			315.6	325			317	324			315.6	319.9		
7.	DISCH. .2C_5 RATE	1.0v		306.6		334.3		305.6		306.8		310		305.3		307		310.2
		0.6v		313.7		338		308.3		311.8		317.7		308		311.4		313
	SHOCK & ACCEL.	NO DISCH	✓		✓		✓		✓		✓		✓		✓		✓	
	DISCH. .2C_5 RATE (ALTITUDE)	1.0v	307.2		310.1		315		304.6		304.8		310.6		332		321.7	
		0.6v	313		313		324		312.7		311.1		313		340		345	
8.	DISCH. .2C_5 RATE	1.0v	352	316	307	348	311.5	311	322	321	345	323	308.4	306.1	314	306	306.8	308.4
		0.6v	360	322	315	351	322	317	329	326	352	329	315	313	321	308.1	310	317
9.	INSPECTION.		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE IX

NOTE: * CELLS DAMAGED DURING ACCELERATION TEST

QUALIFICATION TEST BB442( )/U CELL AS PER SCL 2504A.
(100 AH CYLINDRICAL CELL WITH CERAMIC SEAL)

	SERIAL NUMBER		45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	QUAL. TEST NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	TEST DESCRIPTION																	
1.	INSPECTION	MIN. %	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2.	DISCH. .2C_5 RATE (20 AMPERES)	1.0v	342	347	350	360	351.2	345.1	356.8	324.3	349.8	350.1	343.8	348	344	338	346.3	363
		0.6v	348	351	352.6	363	353	349.6	359	329	355	354	349	353.5	349	342.3	350	368.9
3.	DISCH. .2C_5 RATE	1.0v									369	371.5	353	359	341	352	352.5	351
		0.6v.									372	373	357	362	344	354	356	353
	DISCH .2C_5 RATE (300 AMPERES)	5 SEC. VOLT.	1.155	1155	1.16	1.16	1.16	1.15+	1.15+	1.16								
		1.0v	16.6	16.8	16.5	17.9	16.7	16.9	17.7	16.5								
		0.6v	21.9	22.5	22.7	21.9	21.6	22.8	21.9	20.2								
4.	DISCH. .2C_5 RATE	1.0v					326	325.6	346	336					304	317	324.7	319
		0.6v					327.2	326.8	347.6	337.5					307	319	326.1	321.6
	DISCH. .2C_5 RATE (-40°F)	1.0v	269.5	195.7	272	240.9					274.1	238.7	234.5	226.7				
		0.6v	281.4	222	285	267					293.1	242.9	246.1	240.3				
5.	TEMP. SHOCK	NO DISCH.	✓	✓			✓	✓			✓	✓			✓	✓		
6.	DISCH. .2C_5 RATE	1.0v			333	336.5			353	340			326	339			331	321.5
		0.6v			351.8	342			357	345			331.8	346			335	327
	DISCH. .2C_5 RATE. (VIBRATION)	1.0v	326.2	349.2			321.7	323.2			331.3	329.2			307.3	315.7		
		0.6v	328.2	351.3			325.4	328.1			336.7	331.4			309.2	317.2		
7.	DISCH. .2C_5 RATE	1.0v		352.4		342		327		354.4		343		360		333.5		341.5
		0.6v		354		348		330		357.2		346		364		336.5		346
	SHOCK & ACCEL.	NO DISCH.	✓		✓		✓		✓		✓		✓		✓		✓	
	DISCH. .2C_5 RATE (ALTITUDE)	1.0v	341		345		330.1		357.8		334.8		353.4		350.2		355.7	
		0.6v.	345.6		348.9		331.8		362.1		339.6		359.6		354.1		361.1	
8.	DISCH. .2C_5 RATE	1.0v	349.5	362.4	353	360	365.7	348	378	365.8	354.8	369	364	371.8	344	354	363.5	361.4
		0.6v	373.5	363.7	359	362	368.1	350.7	380.1	370	369.6	371.2	367	373.8	347	357	365.3	364.7
9.	INSPECTION	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TABLE V

GPL Division
GENERAL PRECISION, Inc.
PLEASANTVILLE, NEW YORK

ENVIRONMENTAL TEST REPORT

NO. D-120

ITEM DESCRIPTION

100 Ampere Hour Cells

Teflon Seals

MANUFACTURED BY Gonotone, Elmsford, N.Y.

MFRS PART NO _____ GPL PART NO. _____

QUANTITY Sixteen (16) CHARGE NO. 101-1/65

TEST REQUESTEE J. Herman, Gonotone

TEST CONDUCTED BY A. Zanzarella Wm. Greubel
A. Zanzarella J. Greubel

TEST REPORT BY Wm. Greubel
W. Greubel

APPROVED BY R. Baran DATE 9/26/63
R. Baran
Dynamic Test Section

EXHIBIT 4

GPL DYNAMIC TEST SECTION

TABLE OF CONTENTS

I PURPOSE

1.1 To determine the ability of the 100 ampere hour battery cells to withstand the vibration, shock, acceleration, and altitude tests described below without mechanical or electrical failure.

II TEST SPECIFICATIONS AND INSTRUCTIONS

2.1 Specification SCL-[illegible], paragraphs [illegible] thru [illegible].

2.2 Environmental test request dated [illegible]-63.

III TEST EQUIPMENT

3.1 [illegible] Vibration exciter, Model [illegible]

3.2 [illegible] Control Console, Model [illegible]

3.3 Endevco Accelerometer, Model [illegible]

3.4 Endevco Accelerometer, Model [illegible]

3.5 [illegible] Vibration exciter, [illegible]

3.6 [illegible] Vibration Meter, Model [illegible]

3.7 [illegible] Vibration pickup, Vertical - Type [illegible]

3.8 [illegible] Vibration Pickup, Vibrodyne, Type [illegible]

3.9 [illegible] Vibration pickup, Horizontal - Type [illegible]

3.10 Ballantine VTVM, Model 300

3.11 Hewlett - Packard Audio Oscillator, Model 200D

3.12 Dumont Cathode Ray Oscillograph, Type 304A

3.13 Barry 100 VD Medium Impact Shock Machine

3.14 Krohn-Hite Band Pass Filter

3.15 Endevco Accelerometer, Model [illegible]

III Test Equipment (cont'd)

3.16 Rotary Accelerator

3.17 Rotary Accelerator Console

3.18 Test Fixtures - Supplied by Sonotone Corp.

IV Test Procedure

4.1 Vibration Test

4.1.1 The test specimens were subjected to sinusoidal vibration in each of the 3 mutually perpendicular axis per specification 501-75 Mil-A, paragraphs 4.5.5 and 4.5.6 .

"4.5.5 Low Frequency Vibration - 10:55:10 cps @ 1 oct/min sweep, 20 min/axis 0.060" DOA Amplitude

4.5.6 High Frequency Vibration - 55:2000 cps in 35 min 6 ± 10g "

4.2 Shock Test

4.2.1 The test specimens were subjected to a mechanical impact shock test as follows: 3 shocks per specimen, one shock in each of 3 mutually perpendicular axes, with the shock level of ± 75g re ched in 3 ± 1 milliseconds.

4.3 Acceleration Test

4.3.1 The test specimens were subjected to a acceleration test as follows: Acceleration level 50 g's for a duration of five (5) minutes in each of the four (4) directions outlined below;

1. Perpendicular to the specimens terminals
2. Perpendicular to the specimens terminals (rotated 90°)
3. Parallel to the thrust axis
4. Parallel to the thrust axis inverted 180°

4.4 Altitude Test

4.4.1 The test specimens in an upright position, were subjected to a simulated altitude of 120,000 feet while a five (5) hour discharge test was conducted by Sonotone personnel.

V TEST RESULTS

5.1 Vibration Test

5.1.1 The test specimens were monitored during vibration testing and showed no electrical or mechanical damage

5.2 Shock Test

5.2.1 The test specimens were monitored during mechanical impact shock testing and showed no electrical or mechanical damage.

5.3 Acceleration Test

5.3.1 The test specimens were monitored during acceleration testing and showed no electrical damage in the following two (2) axis:

a) Perpendicular to specimens terminals
c) **Perpendicular to specimens terminals (rotated 90°)**

5.3.2 Upon raising rotary accelerator up to desired speed with specimens parallel to thrust axis (inverted 180°), a tightening bolt sheared allowing four (4) test specimens to be displaced from original position resulting in mechanical and electrical damage to the four specimens. Test was stopped to allow Sonotone to redesign test fixture.

5.3.3 The test specimens mounted on redesigned test fixture were subjected to the remaining two (2) axes of acceleration testing and showed no further electrical or mechanical damage.

5.4 Altitude Test

5.4.1 The test specimens were monitored during altitude testing and showed no further electrical or mechanical damage.

48c

[redacted]

GPL Division
GENERAL PRECISION, Inc.
PLEASANTVILLE, NEW YORK

ENVIRONMENTAL TEST REPORT

NO. D-124

ITEM DESCRIPTION

100 Ampere Hour Cells
Ceramic Seals

MANUFACTURED BY Sonotone, Elmsford, N.Y.

MFRS PART NO. _____ GPL PART NO. _____

QUANTITY Sixteen (16) CHARGE NO. 101-17960

TEST REQUESTEE J. Herman, Sonotone

TEST CONDUCTED BY W. Grunkel

TEST REPORT BY W. Grunkel

APPROVED BY R. Herman DATE 3-26-63
R. Herman
Dynamic Tests Section

EXHIBIT Z

TABLE OF CONTENTS

I PURPOSE

1.1 To determine the ability of the 100 Ampere Hour Battery Cells to withstand the vibration, shock, acceleration, and altitude tests described below without mechanical or electrical failure.

II TEST SPECIFICATIONS AND INSTRUCTIONS

2.1 Specification SCL-75044, paragraphs 4.5.2 thru 4.5.6.

2.2 Environmental Test Request dated 2-25-63.

III TEST EQUIPMENT

3.1 MB Vibration Exciter, Model C-50

3.2 MB Control Console, Model T-60

3.3 Endevco Accelerometer, Model 2221

3.4 Endevco Accelerometer, Model 2215

3.5 LAB Vibration Exciter, MVH-1500

3.6 MB Vibration Meter, Model M3

3.7 MB Vibration Pickup, Vertical - Type A24

3.8 MB Vibration Pickup, Vibromate, Type M

3.9 MB Vibration Pickup, Horizontal - Type L14

3.10 Ballantine Mvm, Model 301

3.11 Hewlett-Packard Audio Oscillator, Model 200C

3.12 Dumont Cathode Ray Oscillograph, Type 304H

3.13 Barry 150 VD Medium Impact Shock Machine

3.14 Krohn-Hite Band Pass Filter

3.15 Endevco Accelerometer, Model 2215

III TEST EQUIPMENT (cont'd)

3.16 Rotary Accelerator

3.17 Rotary Accelerator Console

3.18 Test Fixtures - Supplied by Sonotone Corp.

IV TEST PROCEDURE

4.1 Vibration Test

4.1.1 The test specimens were subjected to sinusoidal vibration in each of the 3 mutually perpendicular axis per specification SCL-7502A, paragraph 4.5.5 and 4.5.6.

"4.5.5. Low Frequency Vibration - 10:55:10 cps @ 1 cps/min sweep, 9 min/axis 0.060" Dbl Amplitude

"4.5.6. High Frequency Vibration - 55:2000 cps in 35 min @ ± 10 g"

4.2 Shock Test

4.2.1 The test specimens were subjected to a mechanical impact shock test as follows: 3 shocks per specimen, one shock in each of 3 mutually perpendicular axes, with the shock level of ± 75g reached in 3 ± 1 milliseconds.

4.3 Acceleration Test

4.3.1 The test specimens were subjected to a acceleration test as follows: Acceleration level 60g's for a duration of five (5) minutes in each of the four (4) directions outlined below:

1) Perpendicular to the specimens terminals rotated 90°
2) [redacted]
3) Parallel to the thrust axis
4) Parallel to the thrust axis inverted 180°

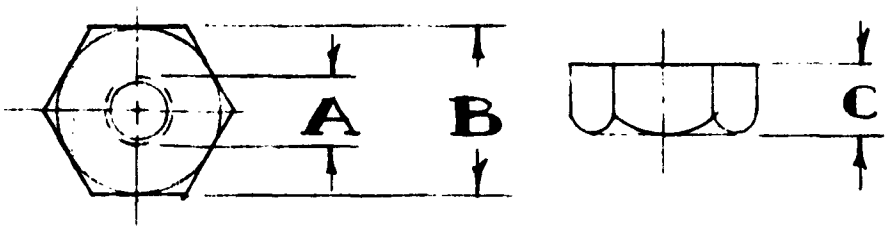
4.4 Altitude Test

4.4.1 The test specimens in an upright position, were subjected to a simulated altitude of 100,000 feet while a five (5) hour discharge test was conducted by ground personnel.

5 Test Results

5.1 Electrical performance of specimens was monitored by the customer and no apparent electrical or visual mechanical damage was found upon completion of testing.

HEX. NUT



SON

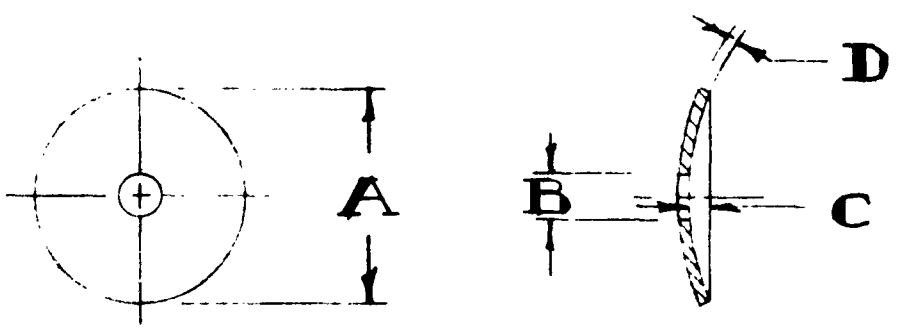
DESCRIPTION

SCALE

ITEM	DE

CELL	ITEM	DIMENSIONS A	B	C	P.D.	MATERIAL	FINISH
BB 440/U	1	10-32	3/8	.125	.1737 .1764	STEEL	COMM. NI.PL.

BELLEVILLE SPRING



1

CELL	ITEM	A	B	C	D	MATERIAL	FORCE TO FLATTEN
BB440/U	1	.375	.195	.012	.0157	SP. ST.	57 ±15%
BB441/U BB442/U	2	.561	.204	.025	.0276	302 S.S.	300 ±15%

Y-	1	DRAWN BY:	CHECKED BY:	ENG. APPROVAL	REG. APPROVAL	CHANGES

SONOTONE CORP. ELMSFORD, N. Y.

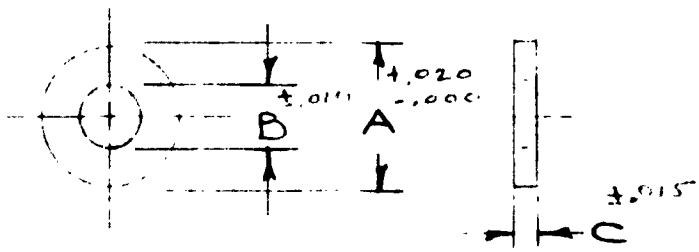
DRAWING & ISSUE NO. Y- P. 4

DESCRIPTION CONNECTING HARDWARE

SCALE _____ BILL OF MATERIAL

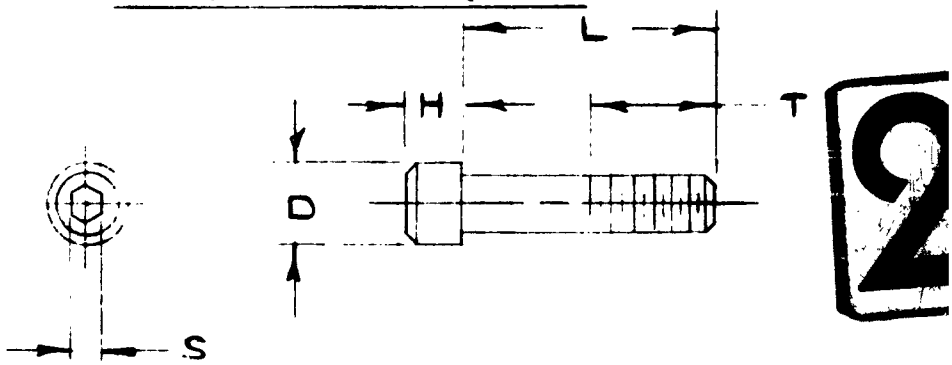
ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.

FLAT WASHER



CELL	ITEM	SCREW SIZE	A	B	C
BB441/U BB442/U	1	#10	.750	.203	.062

CAP SCREW



CELL	ITEM	SIZE	L	T	H	D	S	REMARKS
BB441/U BB442/U	1	10-32	.500	STD.	.190	.312	.156	NI.PL.

FINISH

I.PL.

RIAL	FORCE TO FLATTEN
ST.	57 ±15%
S.S.	300 ±15%

FIG. 12

ASSEMBLIES USED ON

DO NOT SCALE DRAWIN

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SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y- P. 4

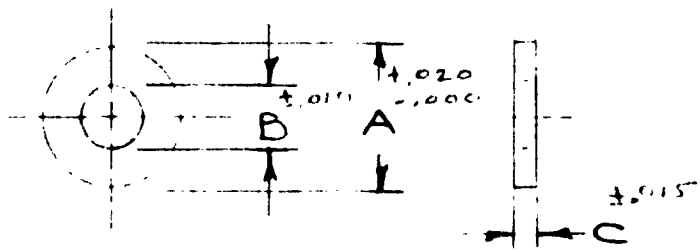
DESCRIPTION CONNECTING HARDWARE

SCALE _____ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.

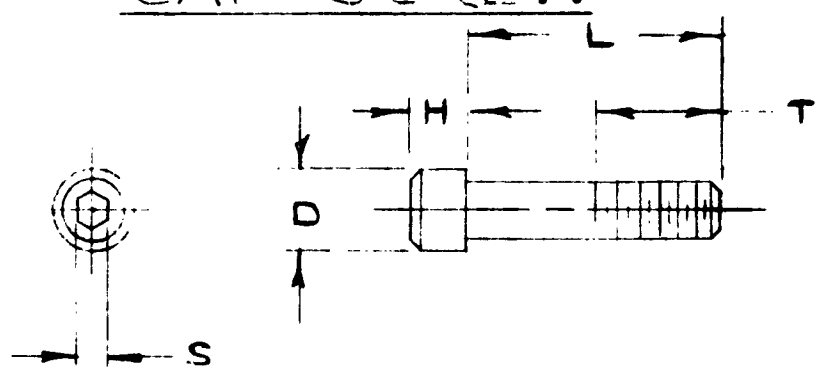
FINISH
I.PL.

FLAT WASHER



CELL	ITEM	SCREW SIZE	A	B	C
BB441/U BB442/U	1	#10	.750	.203	.062

CAP SCREW



RIAL	FORCE TO FLATTEN
ST.	57 ±15%
S.S.	300 ±15%

CELL	ITEM	SIZE	L	T	H	D	S	REMARKS
BB441/U BB442/U	1	10-32	.500	STD.	.190	.312	.156	NI.PL.

FIG. 12

ASSEMBLIES USED ON

DO NOT SCALE DRAWII

IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBE

SONOTONE CORP. ELMSFORD, N. Y.

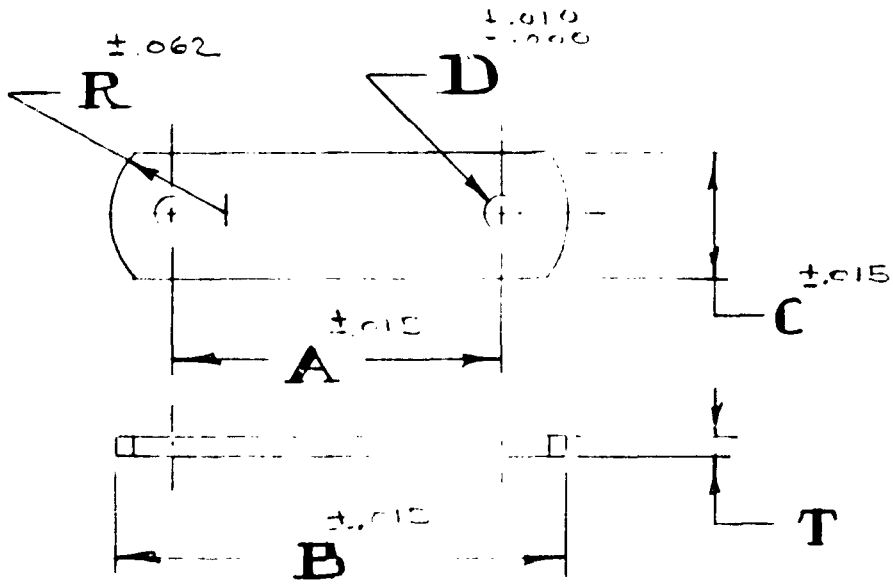
DRAWING & ISSUE NO. Z- P.49A

DESCRIPTION CONNECTING HARDWARE

SCALE _____ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.

CONNECTOR



CELL	ITEM	A	B	C	D	R	T
BB440/U	1	1.093	1.468	.375	.218	.375	.025
BB442/U	2	1.604	2.345	.750	.218	.500	.125
BB441/U	3	1.435	2.185	.750	.218	.500	.125

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FIG. 12

ASSEMBLIES USED ON

SONOTONE CORP. ELMSFORD, N. Y.

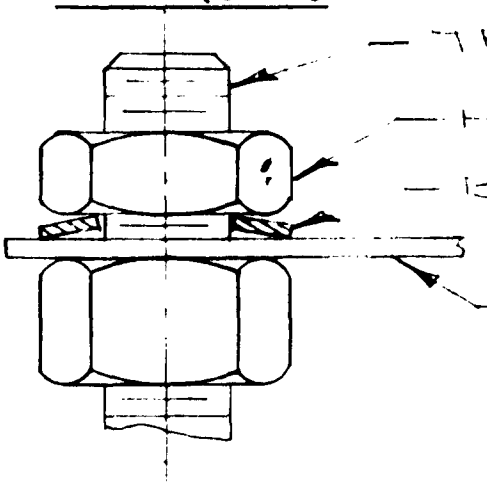
DRA
Z-

DESCRIPTION ASSEMBLY OF CONNECTING HARDWARE

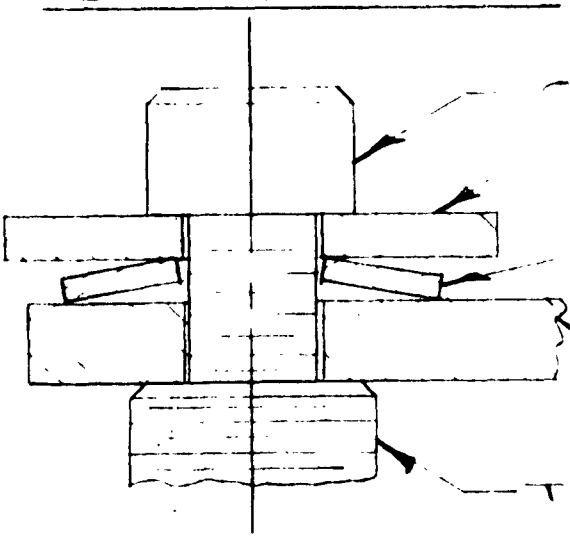
SCALE _____ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN.

10 A.H.



50 & 100 A.H.



IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

Z-	1	DRAWN BY-	CHECKED BY-	ENG. APPROVAL	RES. APPROVAL	CHANGES

VIII. APPENDIX

VIII. APPENDIX

Method of Assembly

Raw plaques are manufactured by sintering nickel powder, using as support a nickel wire screen. On each plaque, the individual plates are then delineated by a coining operation. The coining operation also compresses an area at the top of each plate to allow the spot welding of a contact tab at a later stage in the manufacturing procedure.

The plaques are then loaded with the active materials by impregnating with nitrate solution (nickel nitrate for positive and cadmium nitrate for negative), and electrolyzing in sodium hydroxide solution.

The processed plaques are made into individual plates by cutting through the coined areas. The coined area around the edge of the plate reduces the possibility of loosening of sintered metal or screen wires.

A nickel contact tab is spot welded to each plate. The individual core assemblies (e.g. line 4 of PL 1384) are made by stacking the required number of plates, interleaving them with a continuous layer of separator, which is 1/4 inch wider than the plate height. These core assemblies are kept intact by a thin strip of polyethylene tape.

Method of Assembly (continued)

The tabs are grouped and heli-arc welded in the slots of the collector bars, and the collector bars heli-arc welded to the terminals. In the teflon sealed cells, the terminals are sealed into the covers after the cover is heli-arc welded to the can. In the ceramic sealed cells the terminals are brazed into the covers, then the terminal is welded to the collector bar after which the cover is welded to the can.

In all types of cells, the metal retainers are heli-arc welded to the cover. In the ceramic sealed cells, the brazing is accomplished by firing the cover assembly in a reducing atmosphere furnace at 1800° - 1850°F. Prior to the firing, the silver braze metal, in the form of rings, is positioned (one ring at the upper seal and one ring at the lower seal). The silver flows between the double taper ceramic seal and the cerami-seal metal parts (items 5 and 9 of Figure 5) effecting the seal. The silver wire is 0.031" in diameter.

Prior to welding the cover to can, insulators are placed on the bottom and around the periphery of the core and collector bar assembly, and spacers inserted at the ends and edges of the individual cores. A spacer is also inserted between the collector bars and the top edge of the core assembly. Placement of spacers is detailed in Figure 1, p. 33.

SONOTONE CORP. ELMSFORD, N. Y. PAGE 54A

PARTS LIST

SUBJECT Cylinder Cell Assy - 10 A.H. #1.7731.D

LINE NO.	DESCRIPTION		DRAWING NO.	
1	Cylinder Cell Assy		X24250	
2	Core, Collector Bar & Terminal Assy		Y24227	
3	Core and Collector Bar Assy		Y24230	
4	Core Assy - Center		Y24236	
5	Positive plate & tab Assy		Y24237 Assy 2	
6	Tab		X16143/T. 57	1
7	Nickel Strip		MS20207/T. 5	
8	Positive plate Assy		Y24238 Assy 2	1
9	Cement		MS20007/T. 47	
10	Processed Pos. Plaque		X24214/T. 2	
11	Processed Pos Plaque		X24215/T. 2	
12	Processed Pos Plaque		X24216/T. 2	
13	Coined Plaque		X24211/T. 2	
14	Coined Plaque		X24212/T. 2	
	Coined Plaque		X24213/T. 2	
16	Raw Plaque		X10481/T. 20	1
17	Screen		X10480/T. 1	1
18	Wire Cloth		MS20201/T. 1	
19	Nickel powder		MS20215	
20	Neg. plate & tab Assy		Y24237 Assy 1	1
21	Tab		X16143/T. 57	1
22	Nickel Strip		MS20207/T. 5	
23	Neg. plate Assy		Y24238 Assy 1	1
24	Cement		MS20007/T. 47	
25	Processed Neg. Plaque		X24214/T. 1	4
26	Processed Neg. Plaque		X24215/T. 1	4
27	Processed Neg Plaque		X24216/T. 1	4
28	Coined Plaque		X24211/T. 1	
29	Coined Plaque		X24212/T. 1	
30	Coined Plaque		X24213/T. 1	

ISSUE 1

DRAWN BY J. 1/25/61

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

PAGE 1 OF 4 PAGES

L-1380

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

SUBJECT Cylinder Cell Assy - 10 A.H. - 1.773

LII NO.	DESCRIPTION	DR
1	Raw Plaque	X10
2	Screen	X10
3	Nylon Cloth	MS:
4	Nickel Powder	MS.
5	Separator	MS
6	Polyethylene tape	MS
7	Coin Assy + End	Y24
8	Pos plate & tab Assy	Y24
9	Tab	X16
10	Nickel Strip	MS2
11	Positive plate Assy	Y24
12	Cement	MS2
13	Processed plaque	X2
14	Coined Plaque	X24
15	Raw Plaque	X10
16	Screen	X10
17	Nylon Cloth	MS2
18	Nickel powder	MS
19	Neg. Plate & tab Assy	Y24
20	Tab	X16
21	Nickel Strip	MS2
22	Neg. plate Assy	Y24
23	Cement	MS2
24	Processed Neg Plaque	X24
25	Coined Plaque	X24
26	Raw Plaque	X10
27	Screen	X10

P.L.-1380	ISSUE 1	DRAWN BY	CHECKED BY	ENG. APPROVAL	RES. APPROVAL	CHANGES
		1/25/61				

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

SUBJECT Cylinder Cell Assy - 10 A.H. - L.2

LIN. NO.	DESCRIPTION
1	Wire Cloth
2	Nickel Powder
3	Separator
4	Polyethylene tape
5	Collector Bar
6	Terminal
7	Cyl. and Bottom Assy
8	Bottom Cover
9	Cylinder Cover
10	Insulator - Bottom
11	Insulator - Side
12	Interior Terminal Insulator
13	Cover and Vent Bushing Assy
14	Cover
15	Retainer - metal
16	Vent Bushing
17	Seal - terminal
18	Washer
19	Nut - terminal
20	"O" Ring
21	Valve Assy - Vent
22	Valve Body
23	"O" Ring Retainer

P.L. - 1380 ISSUE 11

DRAWN BY	CHECKED BY	ENG. APPROVAL	RES. APPROVAL	CHANGES
9/25/61				

PAGE 54 C

...231.D.

PL-/384

DRAWING NO.	REQD.
MS20201/T.1	AS REQ
MS20215	AS REQ
MS20412/T.3	AS REQ
MS20313/T.6	AS REQ
Z23827	2
Y23832	2
Y24233	1
Y23996	1
Y24224	1
Z24217/T.1	1
Z24218	1
Z23833	2
Y24221	1
Y23995	1
Z23831	2
Z22350	1
Z23834	2
Y18100/T.44	2
X15111/T.68	2
Y10343/T.19	1
Z22355	1
Y22356	1
Y22357	1

PAGE 3 OF 4 PAGES

SONOTON...

SUBJECT Cylin...

L NO.	DESCR... (1 2 3 4 5 6 7)
1	"O" Ring
2	Bell[illegible]
3	Val[illegible] S[illegible]
4	Silicon[illegible]
5	Ca[illegible]t[illegible]
6	Electrolyte
7	Spa[illegible] —
8	Spa[illegible] —
9	Spa[illegible] — Co[illegible]
10	Spa[illegible] B[illegible]
	Outline draw[illegible]

PL-/384 ISSUE	DRAWN BY	CHECKED BY	ENG. APPROVAL	RES. APPROVAL	CHANGES	
1	3/1/25/61					ADD LINE 2 11 Y[illegible] LINE 9-2 [illegible] 5/1/61

Table VI

Plate Dimensions

Cell	Plate No.	Width	Height	Thickness
BB440/U	Y24238-1 & 2	1.46"	4.015"	0.023"
"	Y24243-1 & 2	0.89"	4.015"	0.023"
BB441/U	Y24251-1 & 2	2.472"	6.373"	0.023"
"	Y24252-1 & 2	1.883"	6.373"	0.023"
"	Y24253-1 & 2	1.078"	6.373"	0.023"
BB442/U	Y24261-1 & 2	3.390"	6.683"	0.023"
"	Y24262-1 & 2	2.591"	6.683"	0.023"
"	Y24263-1 & 2	1.450"	6.683"	0.023"

SONOTONE CORP. ELMSFORD, N. Y.

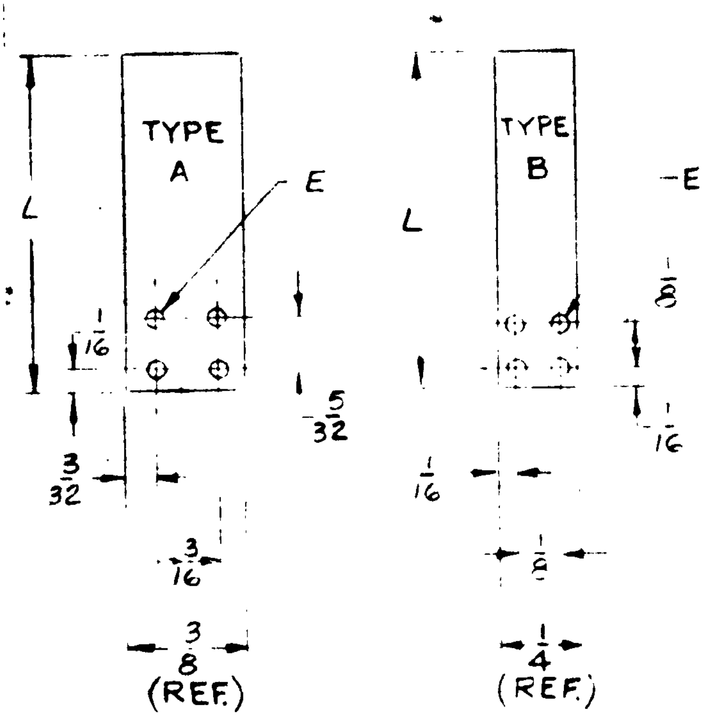
DRAWING & ISSUE NO. Z-

DESCRIPTION CONTACT TAB

SCALE

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	[illegible]



[illegible] NO.	[illegible] NO.	MATERIAL THICKNESS	L ± 1/32	E	[illegible]	#/MAT'L [illegible]/M	PUNCH PER [illegible]	[illegible]
[illegible]	89	.007"	1½	.047	50 [illegible] & 100 [illegible]	.67	B	
161[illegible]	57	.007"	1.375	.047	[illegible] A. [illegible]	1.43	A	

IN REFERRING TO THIS DRAWING STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z- | DRAWN BY. | CHECKED BY. | ENG. APPROVAL | [illegible] APPROVAL | CHANGES

FIG. 13

ASSEMBLIE[S] USED ON

PAGE 57

SONOTONE CORP. ELMSFORD, N. Y.

MATERIAL SPECIFICATION

MS-20,412

ISSUE 1 2 3 4 5

SUBJECT POLY-PROPYLENE

ITEM	DESCRIPTION	THICKNESS	SIZE	SOURCE
1	Exp. 306 POE 20 - 40 CFM PER SQUARE FOOT AT 0.5 INCHES OF WATER. WEIGHT 3.5 OZ. PER SQ. YARD.	.008 - .010		AMERICAN FELT CO.
2	305 PO av. porosity=31 CFM PER SQUARE FOOT AT 0.5 INCHES OF WATER. WEIGHT 2.5 OZ. PER SQ. YARD.	.010 ± .0015		SAME AS IT 1
3	305 POE av. porosity= 22 CFM PER SQUARE FOOT AT 0.5 INCHES OF WATER. WEIGHT 2.5 OZ. PER SQ. YD.	~~.008 max.~~ .0065 - .0085 This Material Not Approved For Transcriptions 6605, 7244, 7077		SAME AS IT 1

NOTE 1: CUT TEN 2 INCH TEST SQUARES AT RANDOM FROM THE FIRST YARD OF POLYPROPYLENE SEPARATOR MATERIAL. PLACE TEST SQUARES IN BOILING 1.4KOH FOR 30 MINUTES. ANY EVIDENCE OF BROWN DISCOLORATION IS CAUSE FOR REJECTION. ANY REJECTED MATERIAL IS TO BE REPORTED TO THE MATERIALS LAB ALONG WITH THE TEST SAMPLE FOR FINAL DESPOSITION.

MS 20,412	PREPARED BY I. MICHALKO	CHECKED	APPROVED 8/19/60	CHANGES	2 Added It. 2 & 3 CN-5316 11/4/60 JV	3 Added It. 3 …	4 Added Note 1 CN-5373 … JV	5 Revised Thickness on It. 2-3 … CN 5532

SHEET 1 OF 1 SHEET

SONOTONE CORP. ELMSFORD, N. Y.

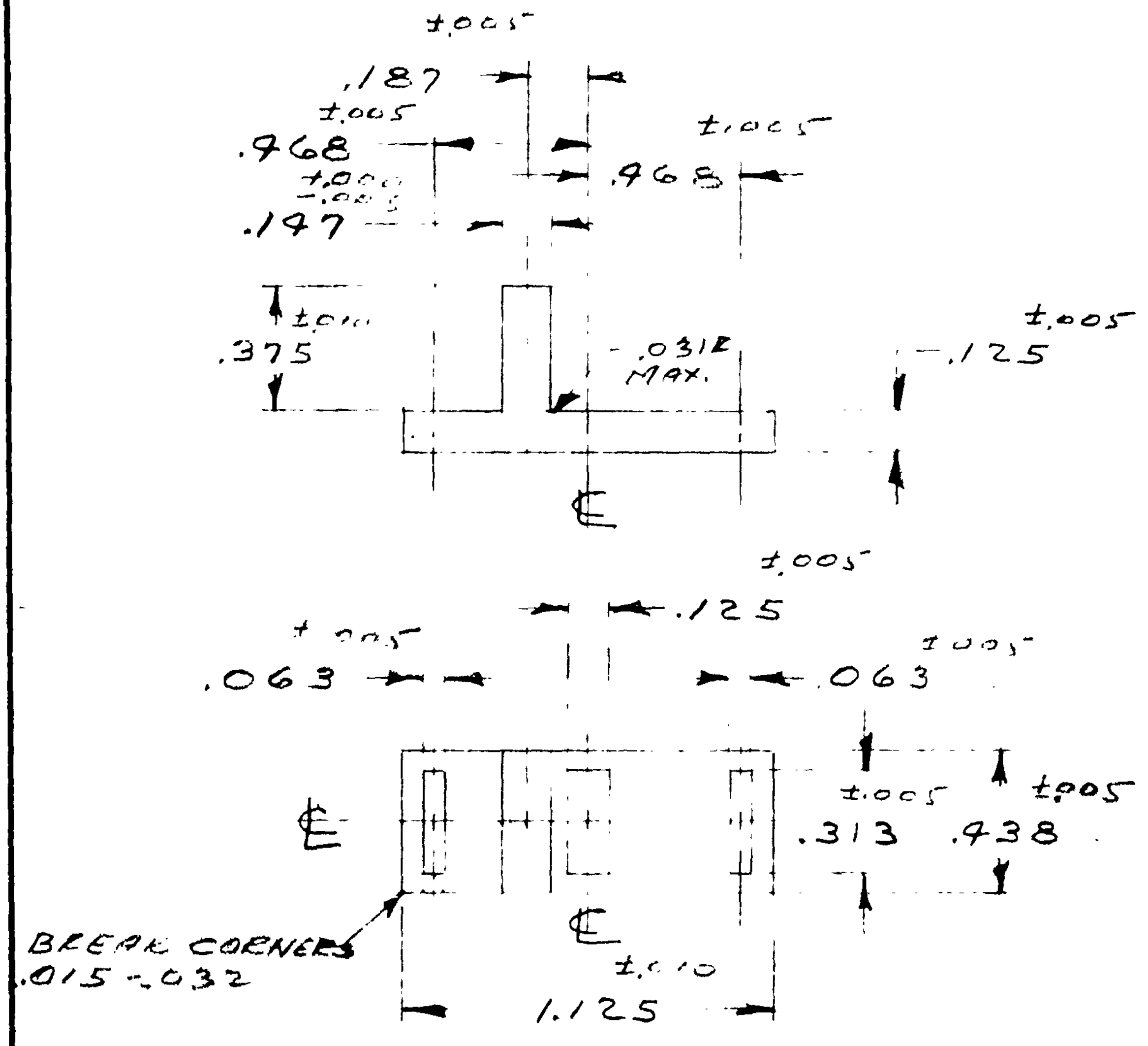
DRAWING & ISSUE NO. Z-23827 / 1

DESCRIPTION COLLECTOR BAR 1.7731.D. 1.745 I.D.

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	C.R.S.				NICKEL PLATE		1



IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

P.L. 1384

Y-24230

Z23E 71

DRAWN BY

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES USED ON

FIG - 14

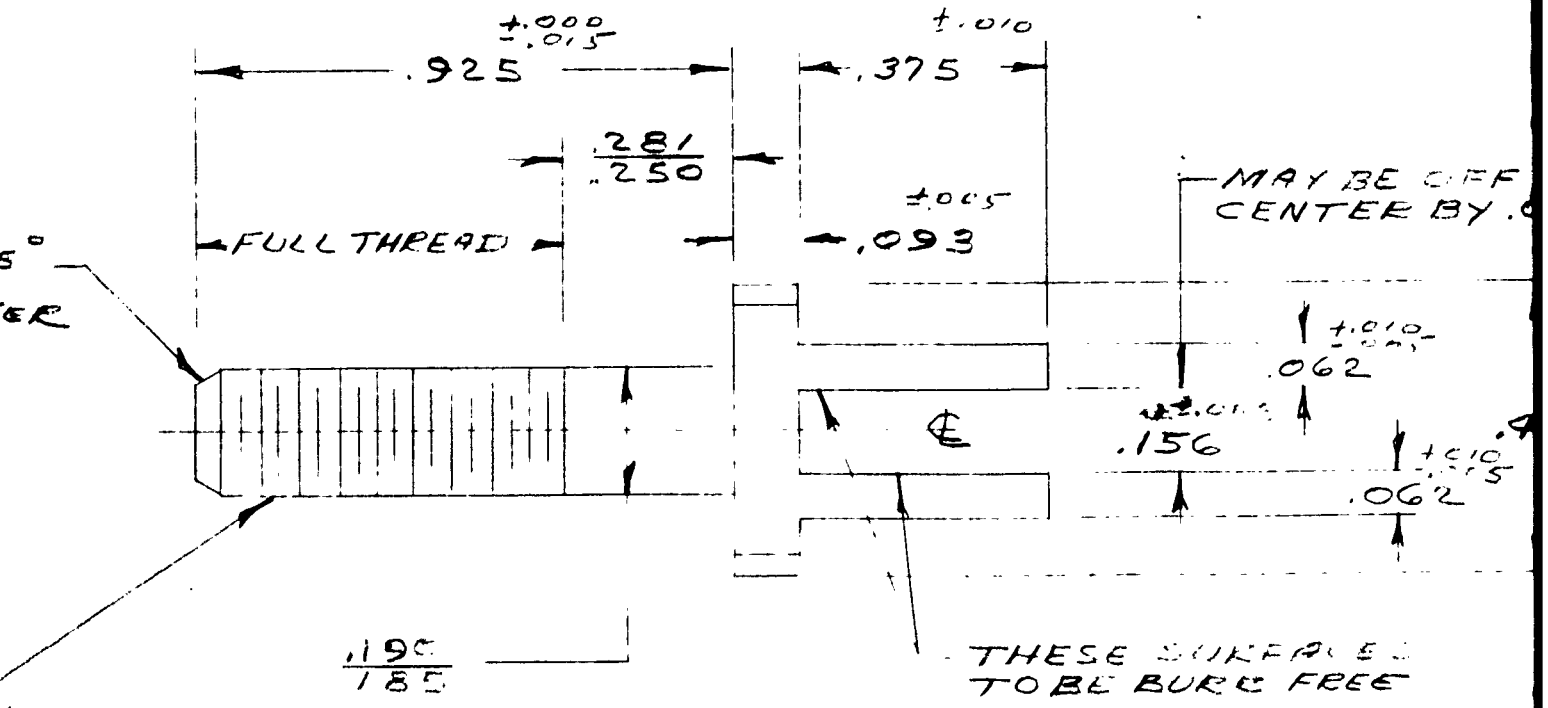
SONOTON

DESCRIPTION TER

SCALE 4X

ITEM	DESCRIPTION
1	C.P. STE 1014 101

NICKE MINIM



10-32 NF-2
O.D. -.189 -.193
P.D. .167 -.169

ENG. APPROVAL	RES. APPROVAL	CHANGES
		1

SONOTONE CORP. ELMSFORD, N. Y.

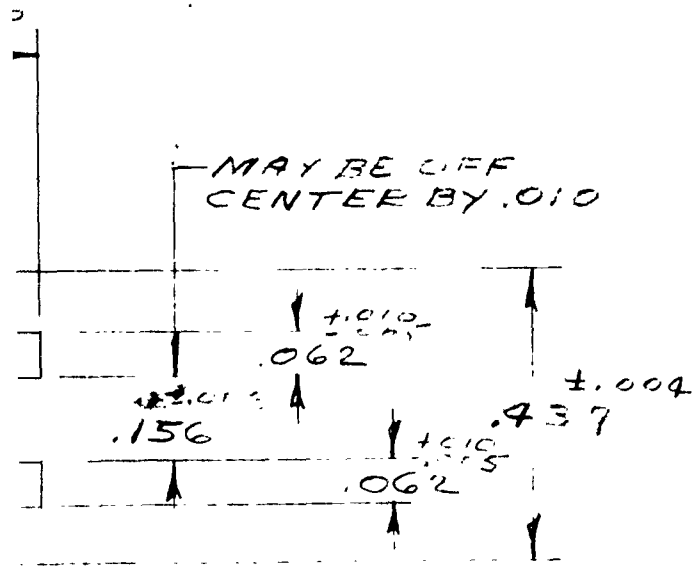
DRAWING & ISSUE NO. Y-2383

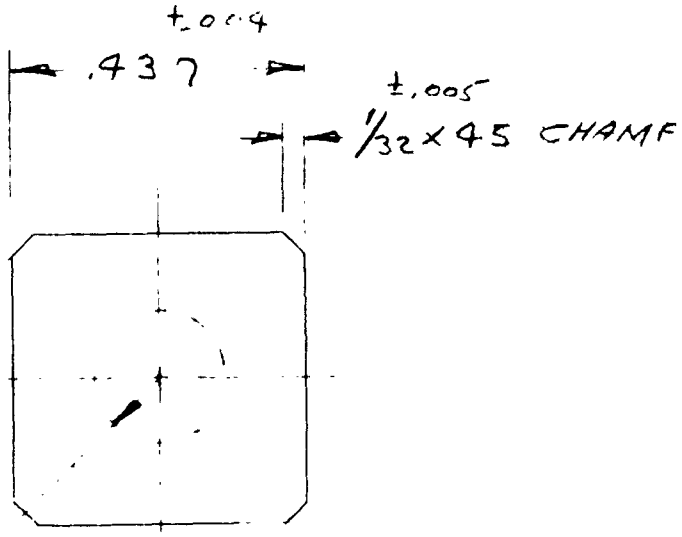
DESCRIPTION TERMINAL 1,245 L.D

SCALE 4X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC
1	C.R. STEEL-SAE 1006 1010 1015 OR 1016					

NICKEL PLATE, .000 5 HEAT TREAT MINIMUM 3 MIN. @ 1400-1700° F





IESE SURFACES BE BURR FREE

— MUST BE CONCENTRIC WITHIN .004 FULL INDICATOR READING.

2

#-1384 Y-24227	DO NOT SCALE DRAWII
ASSEMBLIES USED ON	IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBE

FIG - 15

PAGE 60

SONOTONE CORP. ELMSFORD, N. Y.

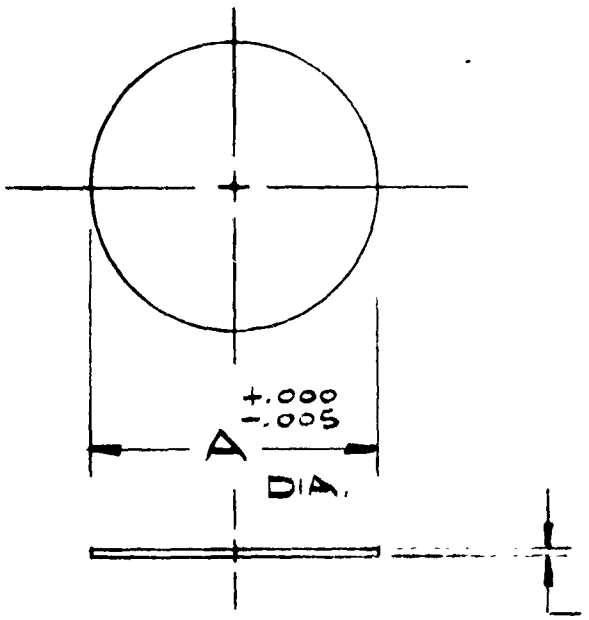
DRAWING & ISSUE NO. Z-24217 | 1

DESCRIPTION BOTTOM INSULATOR

SCALE —

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	A DIA.	MAT'L SPEC.	FIN. SPEC.	QUAL. SPEC.
1	NYLON - ZYTEL #101		1.773	MS-20087 IT. 7		
2	NYLON - ZYTEL #101		2.950	MS-20087 IT. 7		
3	NYLON - ZYTEL #101		3.950	MS-20087 IT. 7		



X-24250 | W-24240

IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

W-24260

R-1384

R-1385

R-1386

ASSEMBLIES USED ON

Z-242 | 1

DRAWN BY: WF 1-25-61

CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

FIG - 16

TAPE 61

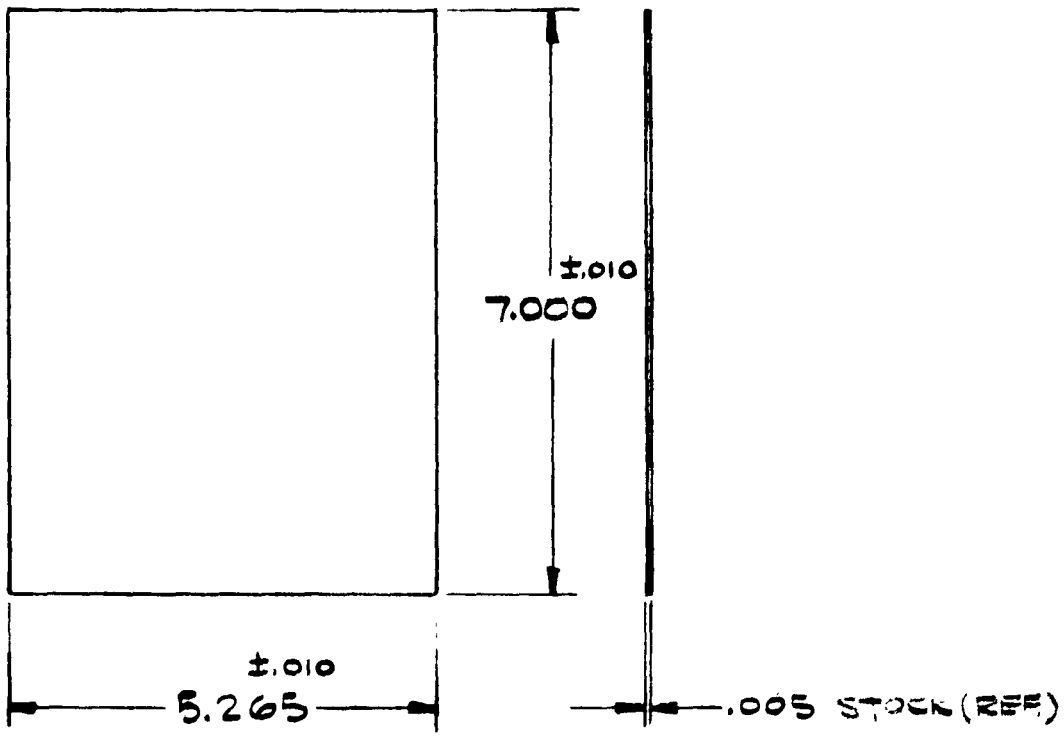
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Z-24218

DESCRIPTION SIDE INSULATOR

SCALE 1/2 SIZE BILL OF MATERIAL 1.773 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON - ZYTEL #101		MS-20087 IT.23				1



IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

Z-24218 | 1

DRAWN BY: LNF 1-25-61

CHECKED BY.

ENG. APPROVAL

REG. APPROVAL

CHANGES

R-1384

X-24250

ASSEMBLIES USED ON

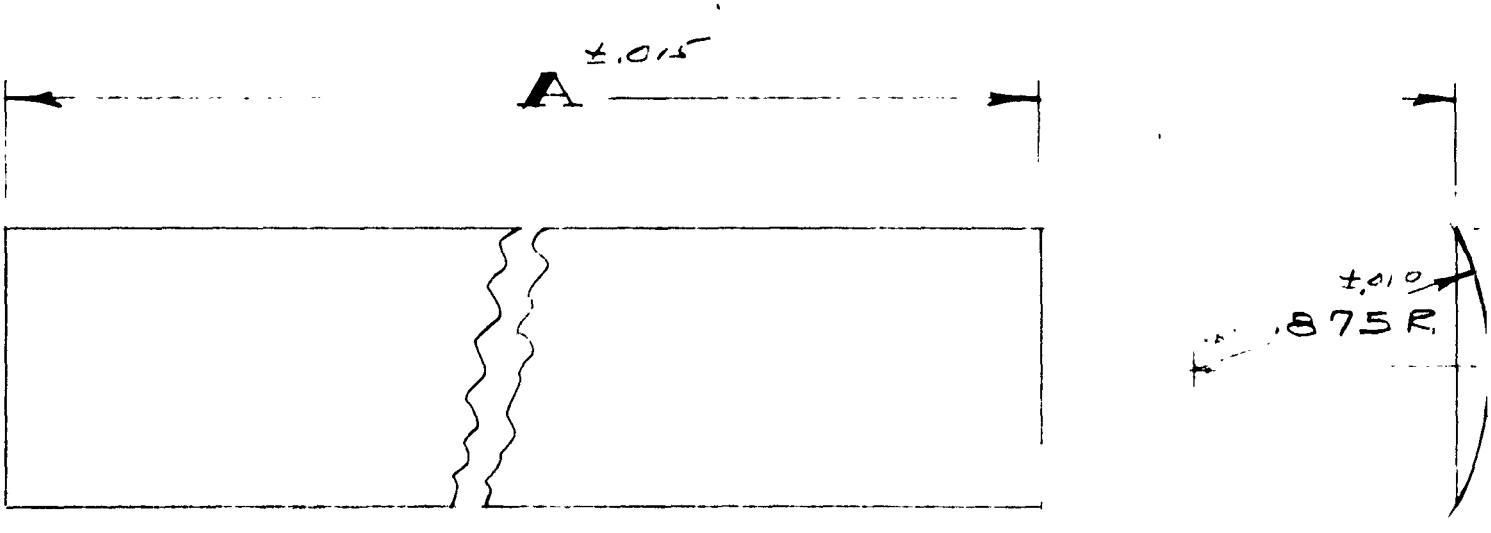
FIG-17

SONOTC

DESCRIPTION SP

SCALE 2X

ITEM	DESCRIPTI
1	NYLON #101
2	NYLON #101



1

ENG. APPROVAL	RES. APPROVAL	CHANGES
		2 5.100 was 5.000 4.160 was 4.125

PAGE 62

SONOTONE CORP. ELMSFORD, N. Y.

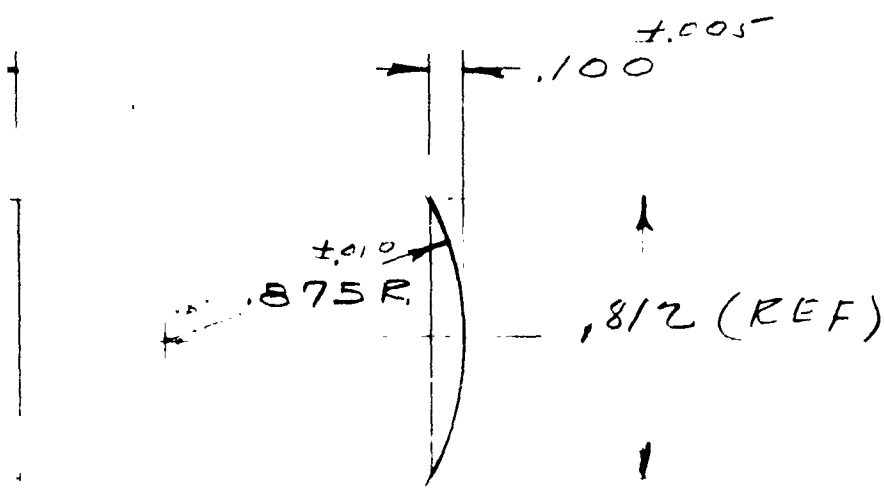
DRAWING & ISSUE NO. Y-24266

DESCRIPTION SPACER - .1773 I.D.

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON - ZYTEL #101			5.100			1
2	NYLON - ZYTEL #101			4.260			1



2

P.L. 15×4

DO NOT SCALE DRAWING

ASSEMBLIES USED ON

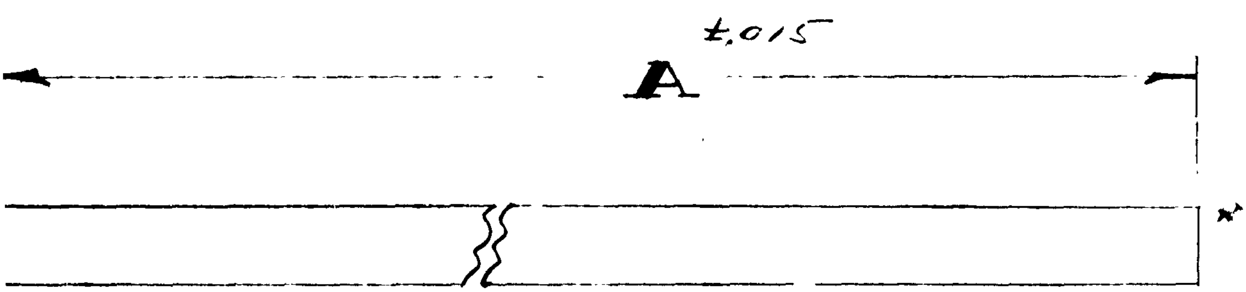
IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER

SONO

DESCRIPTION 5F

SCALE 2X

ITEM	DESCR
1	NYLO. #101
2	NYLO #1



1

CHECKED BY:
ENG. APPROVAL
RES. APPROVAL
CHANGES
2 5.100 WAS 4.60 ADD IT. 2 5/9/61

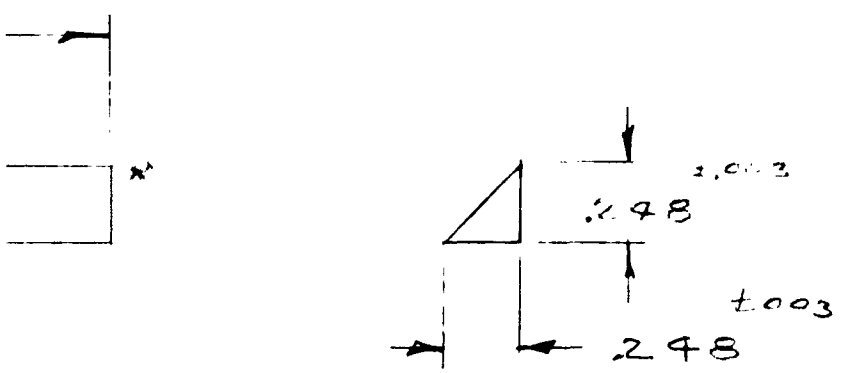
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y-24267 11/2

DESCRIPTION SPACER - CORNER - 1.773 I.D.

SCALE 2X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON - ZYTEL #101			5.100			1
2	NYLON - ZYTEL #101			5.550			1



2

PL. 13 & 14

ASSEMBLIES USED ON

DO NOT SCALE DRAWING

IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER

DE
SC

1

Y242691	
DRAWN BY:	
CHECKED BY:	
ENG. APPROVAL	
RES. APPROVAL	
CHANGES	

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y-24268

DESCRIPTION SPACER BAR - 1.772" D.

SCALE ___ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO	MAT. SPEC	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON ZYTEL #101						1

4 MFGR

2

PC 12×2

ASSEMBLIES USED ON

DO NOT SCALE DRAWING

IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER

FIG - 20

SONOTONE CORP. ELMSFORD, N. Y. Page 65A

PARTS LIST

SUBJECT Cylinder Cell Assy - 50 A.H. - S.9501.D.

ITEM NO.	DESCRIPTION		DRAWING NO.	REQ
1	Cylinder Cell Assy		W24240	1
2	Core, Collector Bar & Terminal Assy		X24228	1
3	Core and Collector Bar Assy		X24231	1
4	Core Assy - Center		Y24244	2
5	Positive plate & tab Assy		Y24247 Assy 2	18
6	Tab		X16143/T.89	18
7	Nickel Strip		MS20207/T.5	
8	Positive plate Assy		Y24251 Assy 2	18
9	Cement		MS20007/T.47	
10	Processed Pos. Plaque		X24216/T.2	9
11	Coined Plaque		X24213/T.2	9
12	Raw Plaque		X10481/T.20	[illegible]
13	Screen		X10480/T.1	[illegible]
14	Wire Cloth		MS20201/T.1	[illegible]
15	Nickel Powder		MS20215	[illegible]
16	Neg. plate & tab Assy		Y24247 Assy 1	18
17	Tab		X16143/T.89	18
18	Nickel Strip		MS20207/T.5	
19	Neg. plate Assy		Y24251 Assy 1	18
20	Cement		MS20007/T.47	
21	Processed Neg. plaque		X24216/T.1	9
22	Coined Plaque		X24213/T.1	9
23	Raw Plaque		X10481/T.4	[illegible]
24	Screen		X10480/T.1	[illegible]
25	Wire Cloth		MS20201/T.1	[illegible]
26	Nickel powder		MS20215	[illegible]
27	Propylene Separator		MS20412/T.3	[illegible]
28	Polyethylene tape		MS20313/T.6	[illegible]

P.L.-1381 ISSUE 1 DRAWN BY Jm 1/26/61 CHECKED BY ENG. APPROVAL RES. APPROVAL CHANGES

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

PAGE 65 B

SUBJECT Cylindrical Cell Assy - 50 A.H. @ 9501.D.

P.L.-1385

LI NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Cover Assy - Nickel to Carbon	Y24245	2
2	Positive plate & tab Assy	Y24298 Assy 2	14
3	Tab	X16143/T.69	14 AS
4	Nickel Strip	MS20207/T.5	REQ
5	Positive plate Assy	Y24252 Assy 2	14
6	Cement	MS20009/T.47	AS REQ
7	Processed Pos. Plaque	X24215/T.2	4 2/3
8	Coined Plaque	X24212/T.2	4 2/3
9	Raw Plaque	X10981/T.20	4 2/3
10	Screen	X10480/T.1	4 AS
11	Wire Cloth	MS20201/T.1	REQ AS
12	Nickel powder	MS20215	REQ
13	Neg. Plate & tab Assy	Y24248 Assy 1	14
14	Tab	X16143/T.69	14
15	Nickel Strip	MS20207/T.5	
16	Neg. plate Assy	Y24252 Assy 1	14
17	Cement	MS20007/T.47	
18	Processed Neg. Plaque	X24215/T.1	4 2/3
19	Coined Plaque	X24212/T.1	4 2/3
20	Raw Plaque	X10481/T.4	4 2/3
21	Screen	X10480/T.1	4 AS
22	Wire Cloth	MS20201/T.1	REQ AS
23	Nickel powder	MS20215	REQ
24	Propolene Separator	MS20412/T.3	AS REQ
25	Polyethylene tape	MS20313/T.4	AS REQ
26	Cover Assy - End	Y24246	2
27	Positive plate & tab Assy	Y24249 Assy 2	10

P.L.-1385 ISSUE 1

DRAWN BY 7/26/61

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

PAGE 2 C

P.L.-1385

SUBJECT Cylinder Cell Assy - 50 KH - 2.950 I.D.

Item No.	DESCRIPTION	DRAWING NO.	REQD
1	Tab	X16143/T.89	10
2	Nickel Strip	MS20207/T.5	
3	Positive plate Assy	Y24253 Assy 2	10
4	Cement	MS20007/T.47	
5	Processed Pos. Plaque	X24216/T.2	10
6	Coined Plaque	X24213/T.2	10
7	Raw Plaque	X10481/T.20	10
8	Screen	X10480/T.1	10
9	Wire Cloth	MS20201/T.1	AS REQ
10	Nickel Powder	MS20215	AS REQ
11	Neg. plate & tab Assy	Y24249 Assy 1	10
12	Tab	X16143/T.89	10
13	Nickel Strip	MS20207/T.5	AS REQ
14	Neg. plate Assy	Y24253 Assy 1	10
15	Cement	MS20007/T.97	AS REQ
16	Processed Neg Plaque	X24216/T.1	10
17	Coined Plaque	X24213/T.1	10
18	Raw Plaque	X10481/T.4	10
19	Screen	X10480/T.1	10
20	Wire Cloth	MS20201/T.1	AS REQ
21	Nickel Powder	MS20215	AS REQ
22	Pregauge Separator	MS20412/T.3	AS REQ
23	Polyethylene tape	MS20313/T.6	AS REQ
24	Collector Bar	Y23856	2
25	Terminal Assy	X18176/T.88	2
	Terminal	Y23854	2
	Yoke	215110/T.14	4

P.L.-1385 ISSUE 1

DRAWN BY 11-26-61

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

SONOTONE CORP. ELMSFORD, N. Y. PAGE [illegible]

PARTS LIST

SUBJECT Cylinder Cell Assy - 50 A.H. - 2.950 I.D.

P.L.-1385

LINE NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Cyl and Bottom Assy	Y24234	1
2	Cover - Bottom	X23998	1
3	Cylinder	Y24225	1
4	Insulator - Bottom	Z24217/T.2	1
5	Insulator - Side	Z24219	1
6	Terminal [illegible]	Z22551/T.1	2
7	Cover and Vent Bushing Assy	Y24220	1
8	Cover	X23997	1
9	Retainer - Crystal	Z23855	2
10	Vent Bushing	Z22350	1
11	Seal - Terminal	Z23857	2
12	Washer	Z19654	2
13	Nut - terminal	X15111/T.3	2
14	"O" Ring	Y10393/T.19	1
15	Valve Assy - Vent	Z22355	1
16	Valve Body	Y22356	1
17	O Ring Retainer	Y22357	1
18	O Ring	Y10393/T.16	1
19	Belleville Spring	Y16128/T.20	1
20	Valve Screw	Z22358	1
21	Silicone Grease - High Vacuum	MS20019/T.16	AS REQ
22	Cement	MS20007/T.14	AS REQ
23	Electrolyte		
24	Spacer Bar	Z24593	1
25	Spacer	Z24593/T.1	2
26	Spacer	Z24592/T.2	2
27	Spacer [illegible]	Z24591/T.1	4
28	Spacer - corner	Z24591/T.2	4
	Outline drawing	Y24264	1

P.L.-1385 ISSUE

DRAWN BY [illegible] 1/26/61 | CHECKED BY | ENG. APPROVAL | RES. APPROVAL | CHANGES

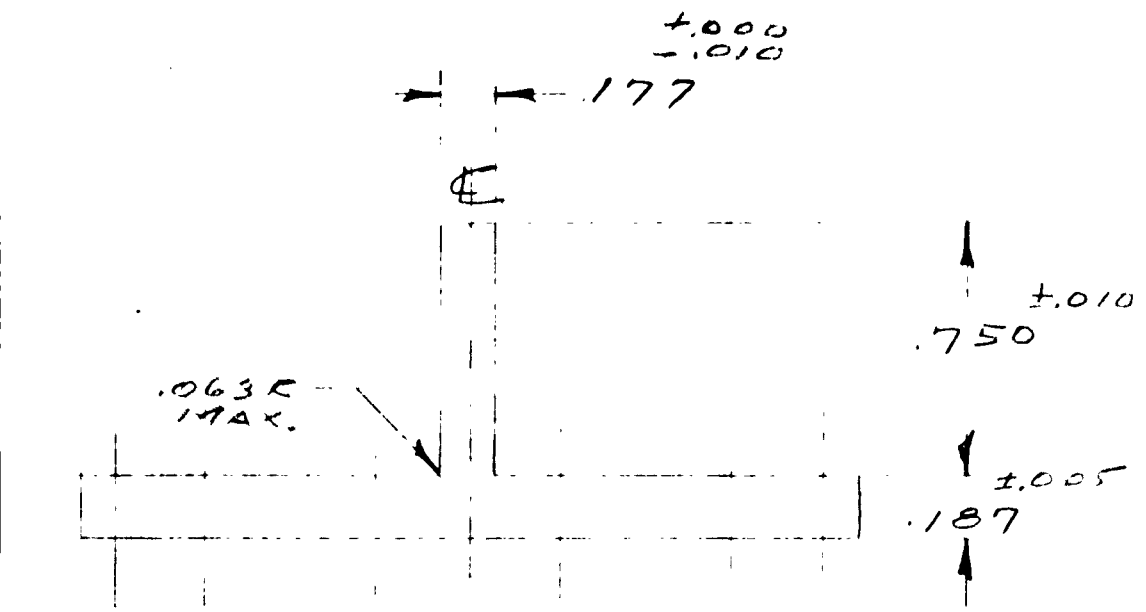
Add Z24593, Z24592/T1, Z24592/T.2, Z24591/T.1, Z24591/T.2 [illegible] 5/10/61

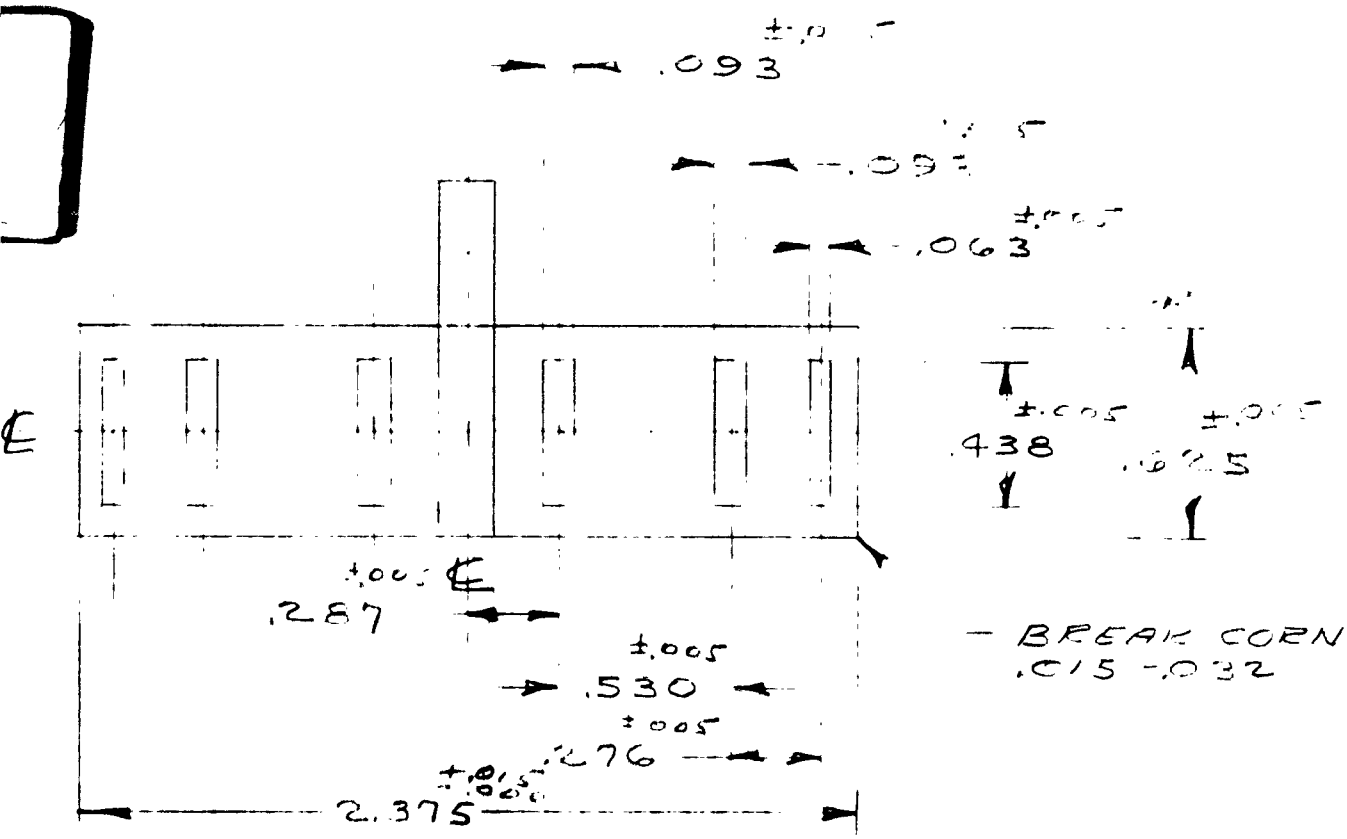
SONOT

DESCRIPTION CO

SCALE 2X

ITEM	DESCRIPT
1	C.R.S.





– BREAK CORNERS
.015 -.032

ENG. APPROVAL	RES. APPROVAL	CHANGES

FACE 2

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y-23856 1

DESCRIPTION COLLECTOR BAR

SCALE 2X BILL OF MATERIAL 2.950 I.D.

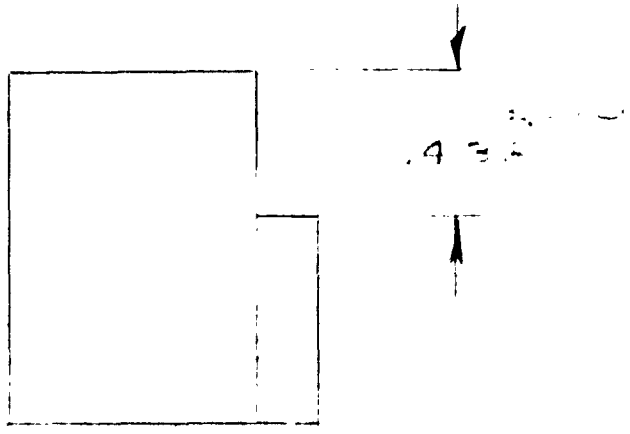
ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	C.R.S.				NICKEL PLATE	

±.010

.005

.005 ±.005

.625



BREAK CORNERS
.015 -.032

2

	X-24231 R-1355	DO NOT SCALE DRAWING
	ASSEMBLIES USED ON	IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER

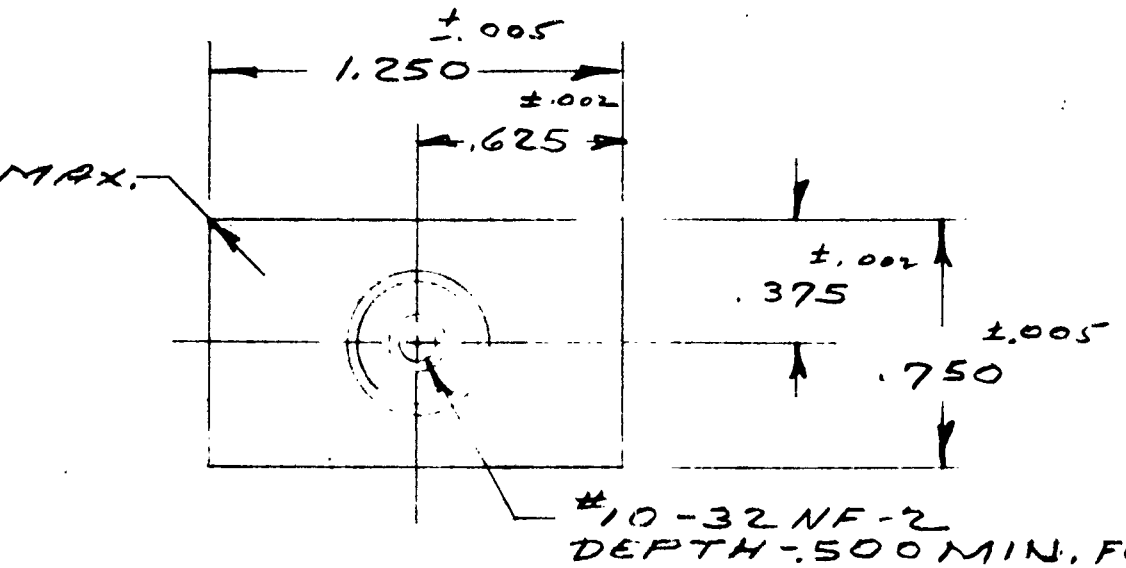
FIG-21

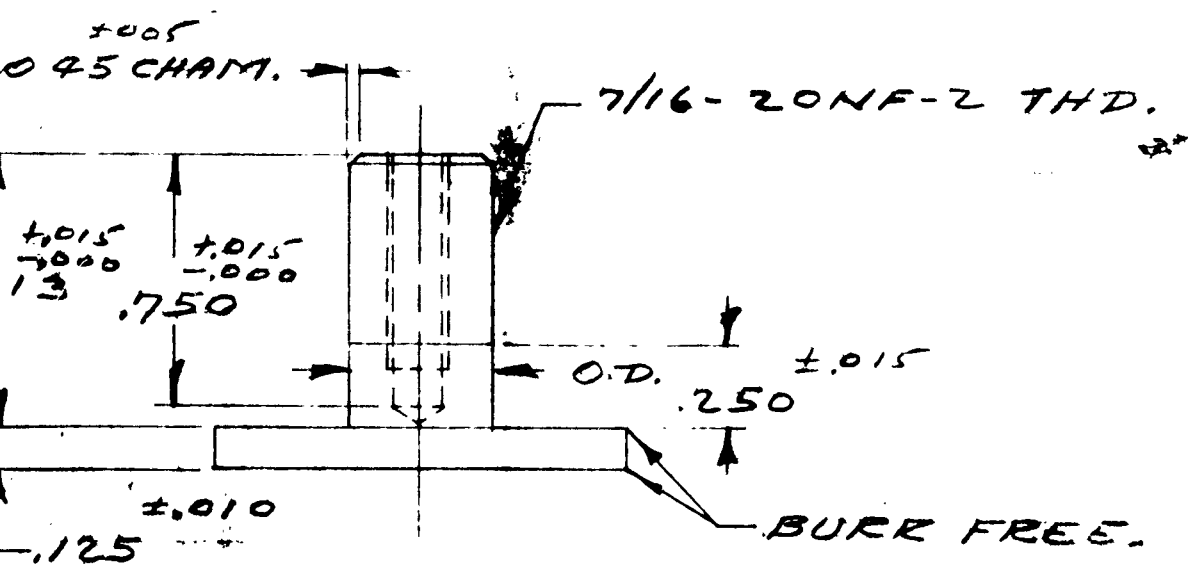
SONOT

DESCRIPTION: TE

SCALE 2X

ITEM	DESCRIPT
1	COLD R SAE 1006





ENG. APPROVAL

REL. APPROVAL

CHANGES

1

PAGE 81

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y-2385 / 1

DESCRIPTION: TERMINAL STUD 50 & 100 A.M.

SCALE 2X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	COLD ROLLED STEEL SAE 1006-1010-1018				NICKEL PLATE	

DOS-

J. FULL THD.

THD.

EE.

2

X-18176	DO NOT SCALE DRAWING
R-1385	
R-1386	IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER
ASSEMBLIES USED ON	

F16-22

PAGE

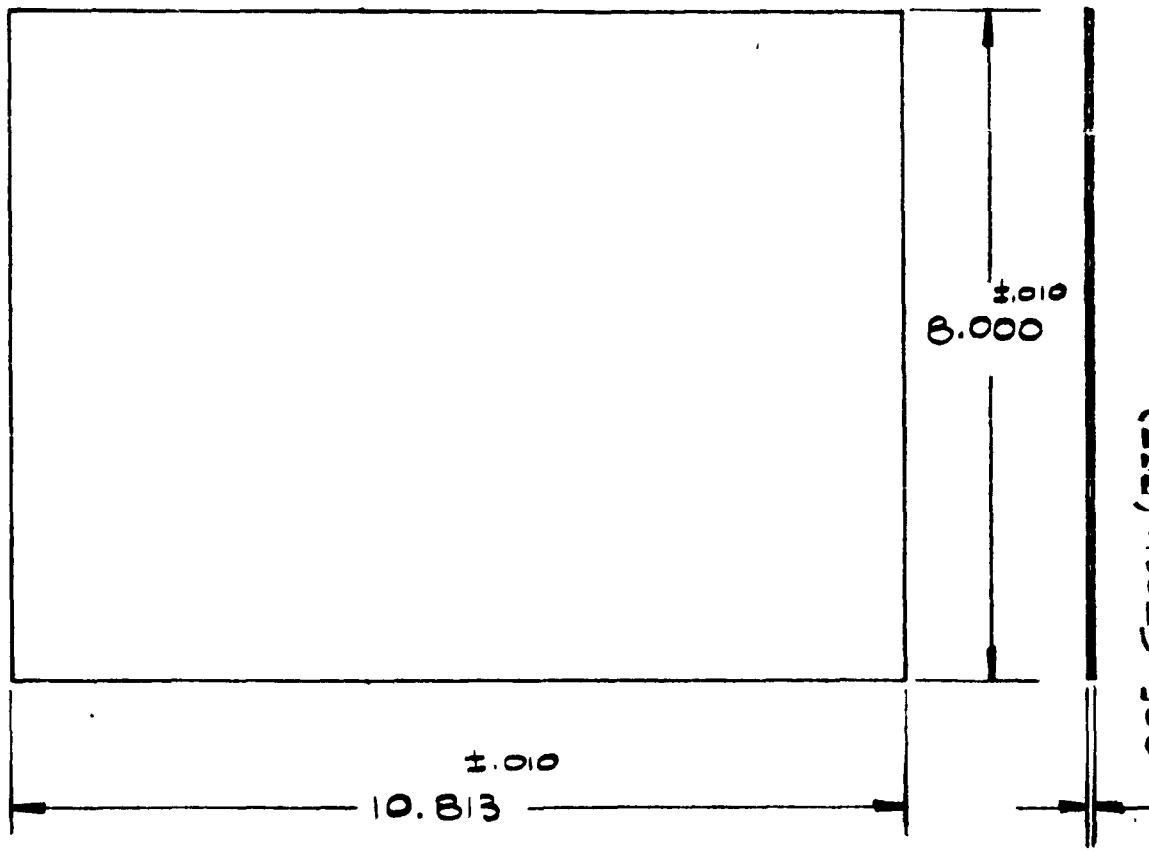
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Z-24219

DESCRIPTION SIDE INSULATOR

SCALE 1/2 SIZE BILL OF MATERIAL 2.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ
1	NYLON - ZYTEL #101		MS-20087 IT. 23				1



IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.	DO NOT SCALE DRAWING

Z-24219 | 1

DRAWN BY: LJF 1-25-61

CHECKED BY:

ENG. APPROVAL

REL. APPROVAL

CHANGES

R-1385

W-24240

ASSEMBLIES USED ON

FIG-23

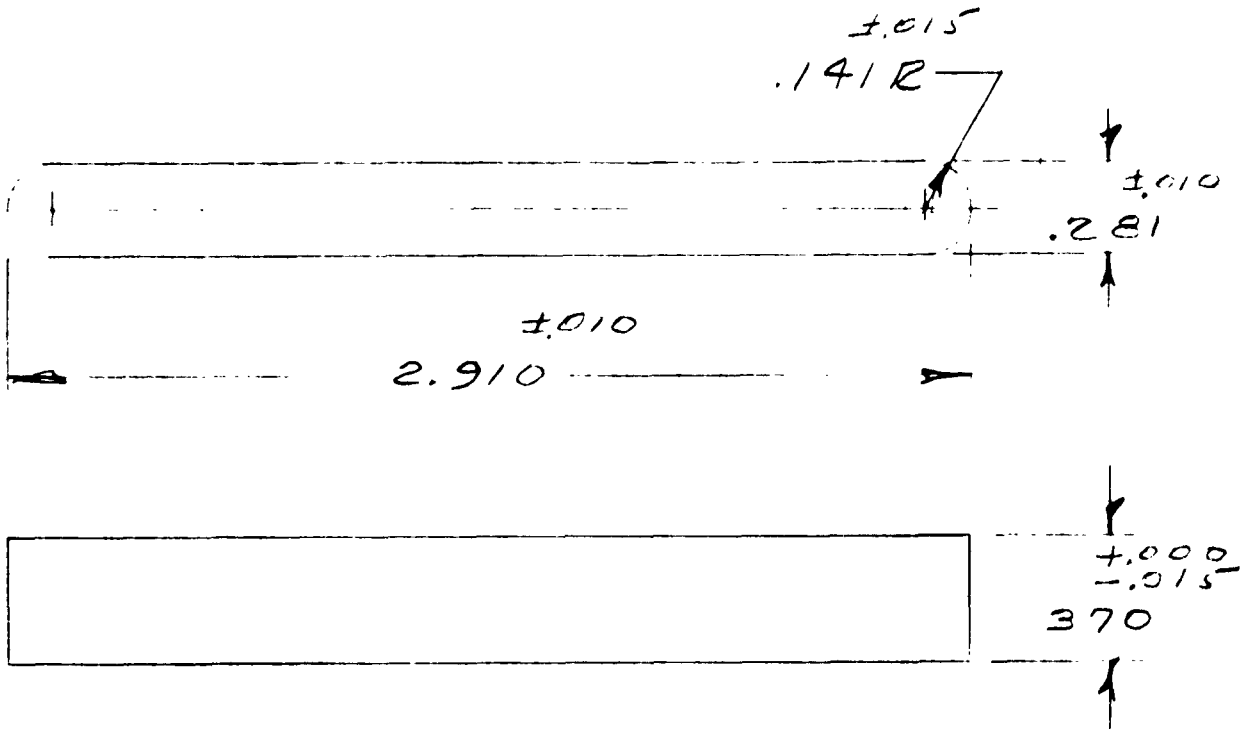
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Z-24593 1

DESCRIPTION SPACER BAR 2.950 I.D.

SCALE 2X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	NYLON-ZYTEL #101					



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DO NOT SCALE DRAWING

Z24593	1	DRAWN BY:	CHECKED BY:	ENG. APPROVAL	RES. APPROVAL	CHANGES

ASSEMBLI
USED ON

FIG- 2.4

APPENDIX

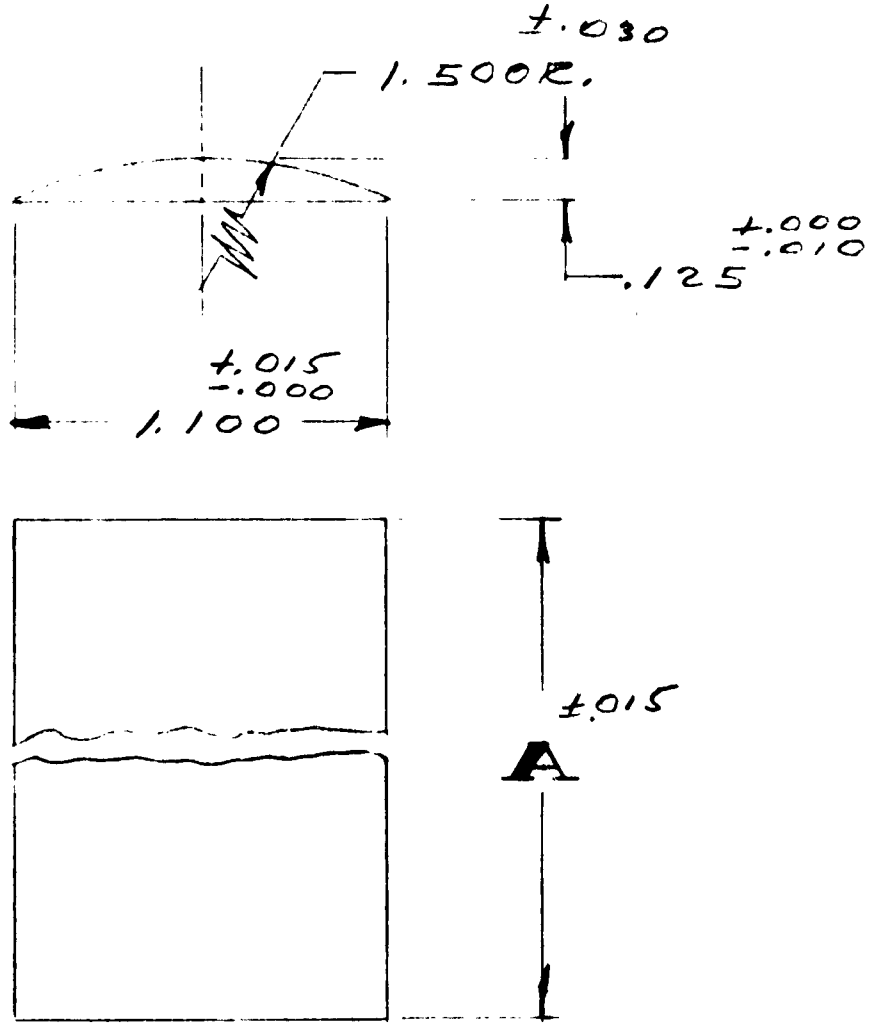
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Z-24592 1

DESCRIPTION SPACER 2.950 I.D. A

SCALE 2X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON - ZYTEL #101			6.600			1
2	NYLON - ZYTEL #101			8.380			1



IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

Z24592 1

DRAWN BY: Jm 5/10/61

CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES USED ON

F16-25

SONOTONE CORP. ELMSFORD, N. Y.

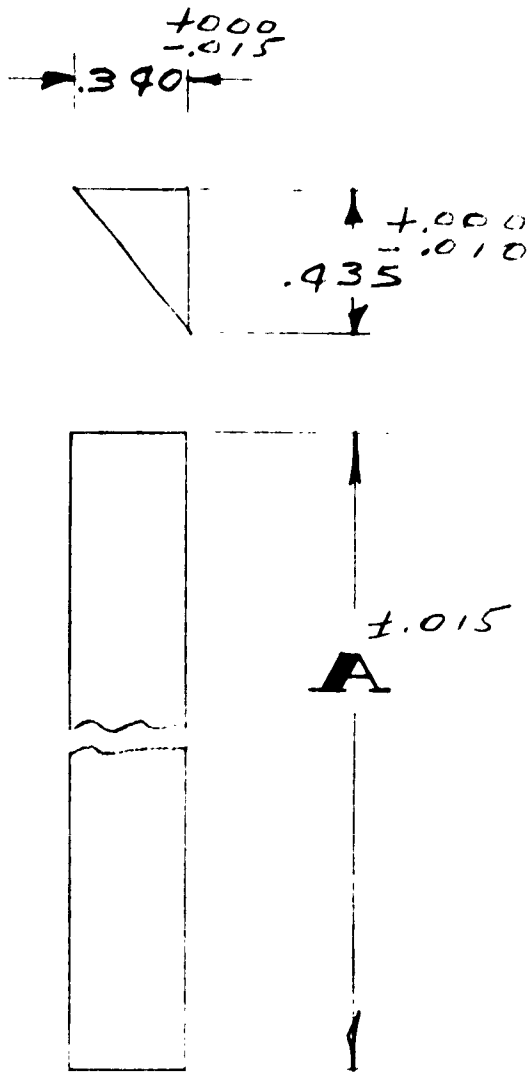
DRAWING & ISSUE NO. Z-24591

DESCRIPTION SPACER - CORNER 2.950 A

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON - ZYTEL #101			7.000			1
2	NYLON - ZYTEL #101			8.380			1



IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

Z2459 1

DRAWN BY,

CHECKED BY-

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES USED ON

SONOTONE CORP. ELMSFORD, N. Y. PAGE 72 A

PARTS LIST

SUBJECT Cylindrical Cell Assy - 100 A.H. - 3.950 I.D.

P.L. 1384

ITEM NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Cylindrical Cell Assy	W24260	
2	Core, Collector Bar & Terminal Assy	X24229	
3	Core and Collector Bar Assy	X24232	
4	Core Assy - Center	Y24254	2
5	Positive plate & tab Assy	Y24257 Assy 2	24
6	Tab	X16143/T.89	24
7	Nickel Strip	MS20207/T.5	AS REQ'D
8	Positive plate Assy	Y24261 Assy 2	24
9	Cement	MS20007/T.97	AS REQ'D
10	Processed Pos. Plaque	X24214/T.2	8
11	Coined Plaque	X24211/T.2	8
12	Raw Plaque	X10481/T.20	8
13	Screen	X10480/T.1	8
14	Nylon Cloth	MS20201/T.1	AS REQ'D
	Nickel Powder	MS20215	AS REQ'D
16	Neg. Plate & tab Assy	Y24257 Assy 1	24
17	Tab	X16143/T.89	24
18	Nickel Strip	MS20207/T.5	AS REQ'D
19	Negative plate Assy	Y24261 Assy 1	24
20	Cement	MS20007/T.97	AS REQ'D
21	Processed Neg Plaque	X24212/T.1	8
22	Coined Plaque	X24211/T.1	8
23	Raw Plaque	X10481/T.4	8
24	Screen	X10480/T.1	8
25	Nylon Cloth	MS20201/T.1	AS REQ'D
26	Nickel Powder	MS20215	AS REQ'D
27	Propylene Separator	MS20412/13	AS REQ'D
28	Polyethylene tape	MS20313/T6	AS REQ'D

P.L. 1384 ISSUE 1

DRAWN BY | CHECKED BY | ENG. APPROVAL | RES. APPROVAL | CHANGES

PAGE 1 OF 4 PAGES

SONOTONE CORP. ELMSFORD, N.Y.

PARTS LIST

PL-1386

SUBJECT Cylinder Cell Assy - 100 A.H. - 3.9501.D.

LINE NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Core Assy - Mett to Center	Y24255	2
2	Positive plate & tab Assy	Y24258 Assy 2	20
3	Tab	X16143/T.89	20
4	Nickel Strip	MS20207/T.5	AS REQ
5	Positive plate Assy	Y24262 Assy 2	20
6	Cement	MS20007/T.47	AS REQ
7	Processed Pos. Plaque	X24216/T.2	10
8	Coined Plaque	X24213/T.2	10
9	Raw Plaque	X10481/T.20	10
10	Screen	X10480/T.1	10
11	Wire Cloth	MS20201/T.1	AS REQ
12	Nickel Powder	MS20215	AS REQ
13	Neg. Plate & tab Assy	Y24258 Assy 1	20
14	Tab	X16143/T.89	20
15	Nickel Strip	MS20207/T.5	
16	Neg. plate Assy	Y24262 Assy 1	2[illegible]
17	Cement	MS20007/T.47	[illegible]
18	Processed Neg. Plaque	X24216/T.1	1[illegible]
19	Coined Plaque	X24213/T.1	1[illegible]
20	Raw Plaque	X10481/T.4	1[illegible]
21	Screen	X10480/T.1	1[illegible]
22	Wire Cloth	MS20201/T.1	[illegible]
23	Nickel powder	MS20215	[illegible]
24	Propylene Separator	MS20412/T.3	[illegible]
25	Polyethylene tape	MS20313/T.6	[illegible]
26	Core Assy - End	Y24256	2
27	Positive plate & tab Assy	Y24259 Assy 2	1[illegible]

PL-1[illegible] ISSUE 1

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SONOTONE CORP. ELMSFORD, N. Y. PAGE 72C

PARTS LIST

SUBJECT: Cylinder Cell Assy - 100 AH. - 3.950 I.D.

P.L.-1386

LI. NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Tab	X16143/T.89	14
2	Nickel Strip	MS20207/T.5	AS REQ
3	Positive Plate Assy	Y24263 Assy 2	14
4	Cement	MS20007/T.47	AS REQ
5	Processed Pos. Plaque	X24215/T.2	4
6	Coined Plaque	X24212/T. 2	4
7	Raw Plaque	X10481/T.20	4
8	Screen	X10480/T. 1	4
9	Wire Cloth	MS20201/T. 1	AS REQ
10	Nickel Powder	MS20215	REQ
11	Negative Plate & Tab Assy	Y24259 Assy 1	14
12	Tab	X16193/T.89	14
13	Nickel Strip	MS20207/T.5	AS REQ
14	Negative Plate Assy	Y24268 Assy 1	14
15	Cement	MS20007/T.47	AS REQ
16	Processed Neg. Plaque	X24215/T.7	4
17	Coined Plaque	X24212/T.1	4
18	Raw Plaque	X10481/T. 4	4
19	Screen	X10480/T. 1	4
20	Wire Cloth	MS20201/T.1	AS REQ
21	Nickel Powder	MS20215	REQ
22	Propylene Separator	MS20412/T.3	AS REQ
23	Polyethylene tape	MS20313/T.6	AS REQ
24	Collector Bar	Y23859	2
25	Terminal Assy	X18176/T.88	2
26	Terminal	Y23854	2
27	Screw	2151101/T.14	4

P.L.-1386 ISSUE 1	DRAWN BY	CHECKED BY	ENG. APPROVAL	RES. APPROVAL	CHANGES
	Sm 1/24/61				

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

PL-1386

SUBJECT Cylindrical Cell Assy - 100 A.H. - 3.950 I.D.

LINE NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Cyl. and Bottom Assy	Y24335	1
2	Cover - Bottom	X24200	1
3	Cylinder	Y24226	1
4	Insulator - Bottom	Z24217/T.3	1
5	Insulator - Side	Z24220	1
6	Intercell Terminal Washer	Z22551/T.1	2
7	Cover & Vent Bushing Assy	Y24223	1
8	Cover	X23999	1
9	Retaining Metal	Z23855	2
10	Vent Bushing	Z22350	1
11	Seal - terminal	Z23857	2
12	Washer	Z19654	2
13	Nut - terminal	X15111/T.3	2
14	"O" Ring	Y10343/T.9	1
15	Valve Assy - Vent	Z22255	1
16	Valve Body	Y22256	1
17	"O" Ring Retainer	Y22257	1
18	"O" Ring	Y10343/T.16	1
19	Belleville Spring	Y16128/T.20	1
20	Valve Screw	Z22358	1
21	Screw - Pan Head [illegible]	MS20014/T.16	A.Req
22	Cement	MS2[illegible]007/T.14	A.Req
23	Electrolyte		
24	Spacer Bar	Z24596	1
25	Spacer	Z24595/T.1	2
26	Spacer	Z24595/T.2	2
27	Spacer - corner	Z24594-1	4
28	Spacer - corner	Z24594-2	4
	Outline Drawing	Y24265	

P.L-1381 ISSUE 4

DRAWN [illegible] 7/26/6[illegible]

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

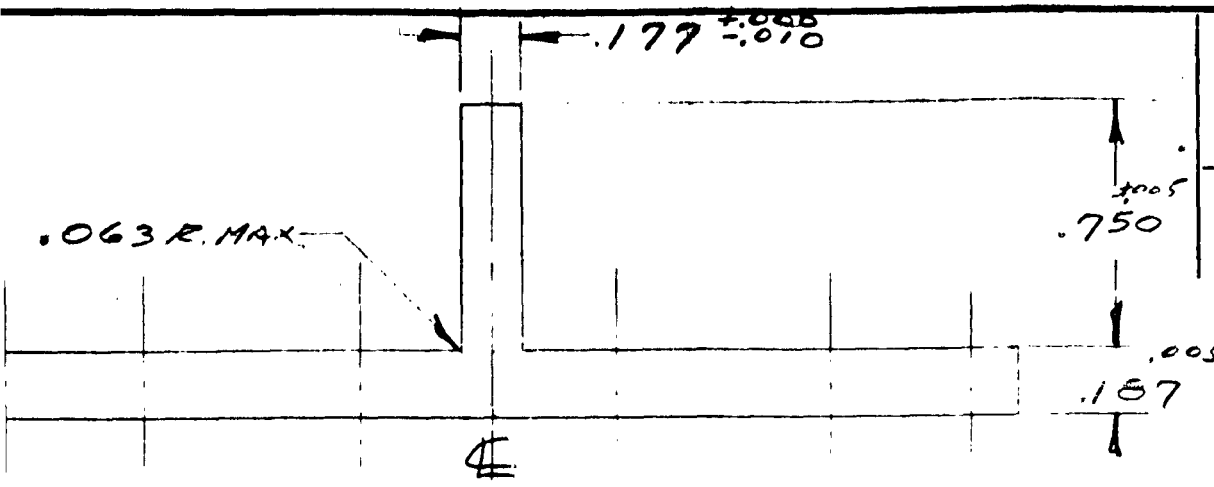
CHANGES

2 ADD Z24596, Z24595/T.1, Z24595/T.2, Z24594 [illegible]

3 Z24594-1 was Z24594, 4 REQ [illegible]; ADD Z24594-2, 4 REQ, 6/28/61

4 LINE 5 WAS Z-24229, CN 17692, F.A.GAGE 6-1-62

PAGE 4 OF 4 PAGES



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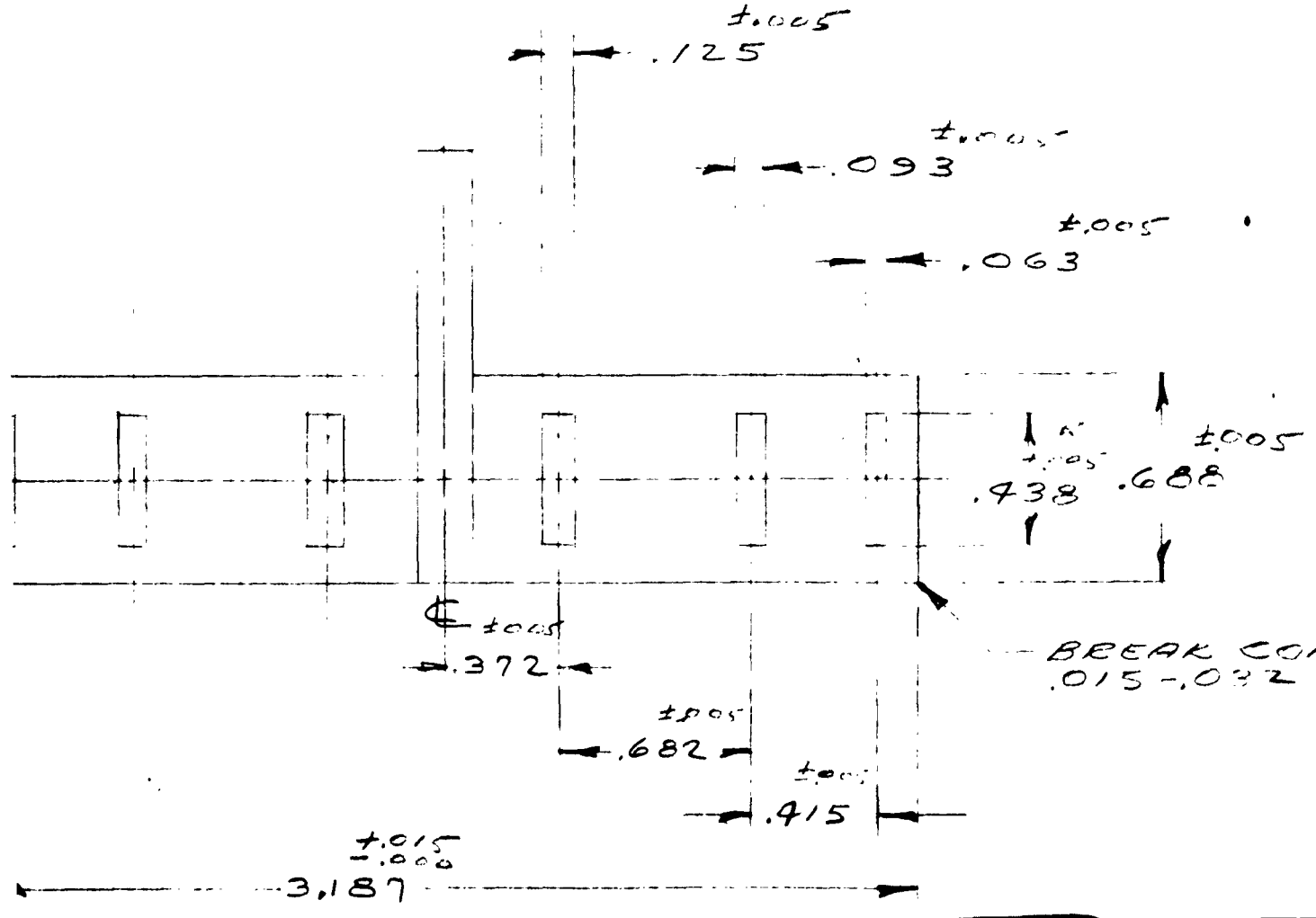
DESCRIPTION COLLE

SCALE

ITEM	DESCRIPTIO
1	C. R. S.



RES. APPROVAL	CHANGES

1

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y-23859 / 1

DESCRIPTION COLLECTOR BAR

SCALE _____ BILL OF MATERIAL 3.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	C. R. S.				NICKEL PLATE		1

±.005
.750

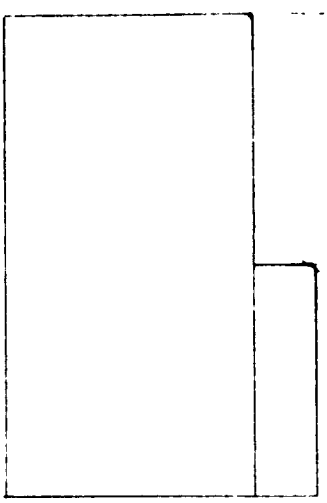
.005
.187

±.005
.063

±.010
.750

±.005
.438

±.005
.688



BREAK CORNERS
.015-.032

2

	X-24232 R-1386 ASSEMBLIES USED ON	DO NOT SCALE DRAWING IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER

FIG-27

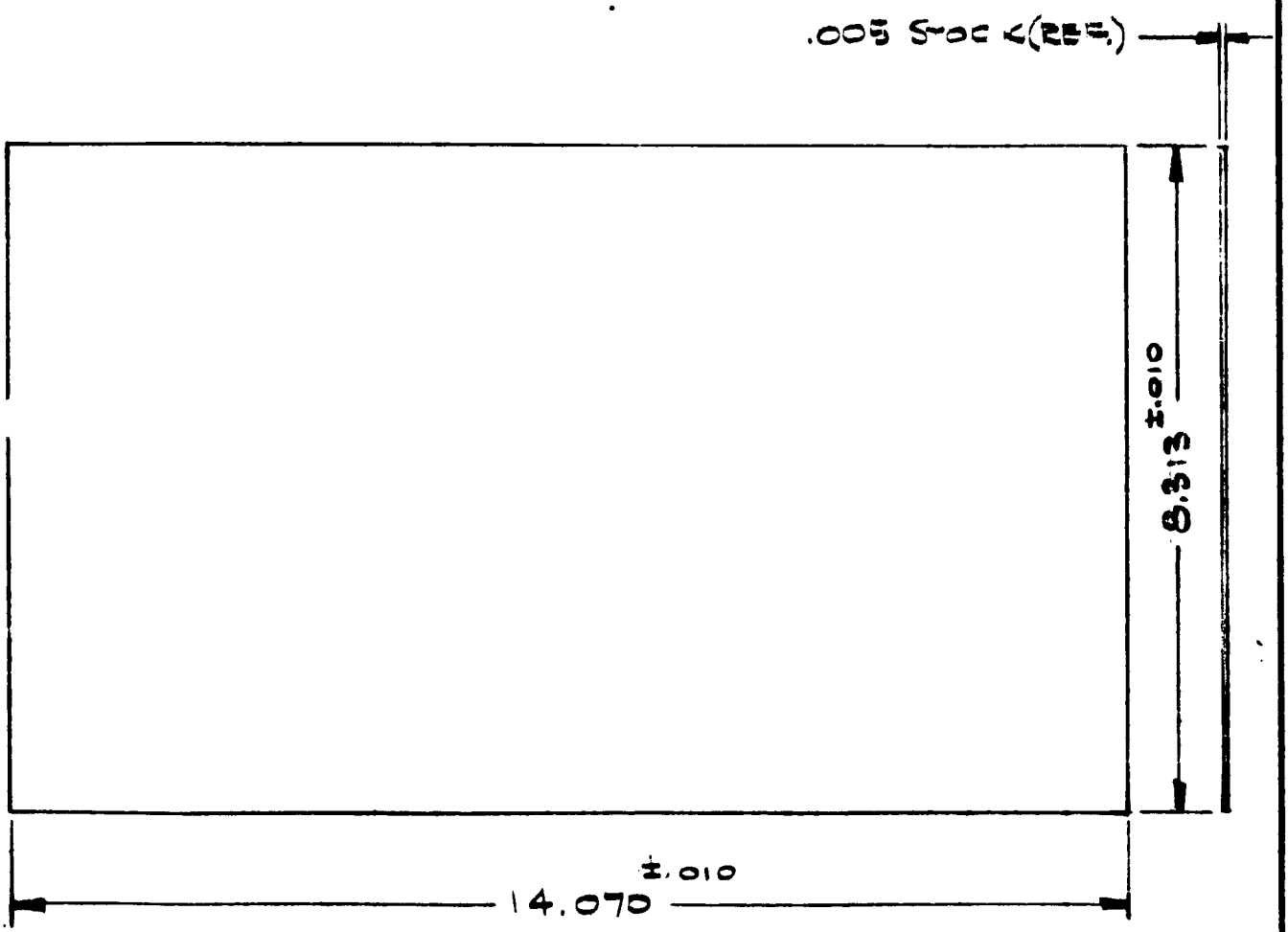
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Z-24220

DESCRIPTION SIDE INSULATOR

SCALE 1/2 SIZE BILL OF MATERIAL 3.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON- ZYTEL #101		MS-20087 IT-23				1



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DO NOT SCALE DRAWING

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R-1386

W.24260

ASSEMBLIES USED ON

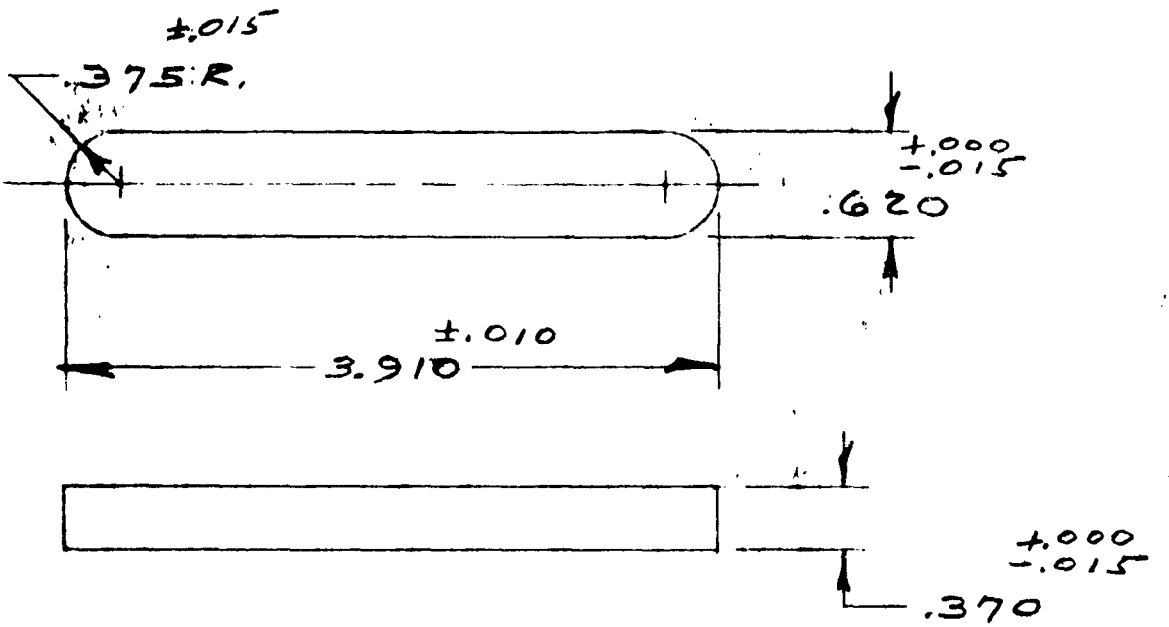
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Z-24596 / 1

DESCRIPTION SPACER-BAR 3.950 L.D.

SCALE FULL BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-ZYTEL #101						1



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DO NOT SCALE DRAWING

Z24596 1

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CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES USED ON

SONOTONE CORP. ELMSFORD, N. Y.

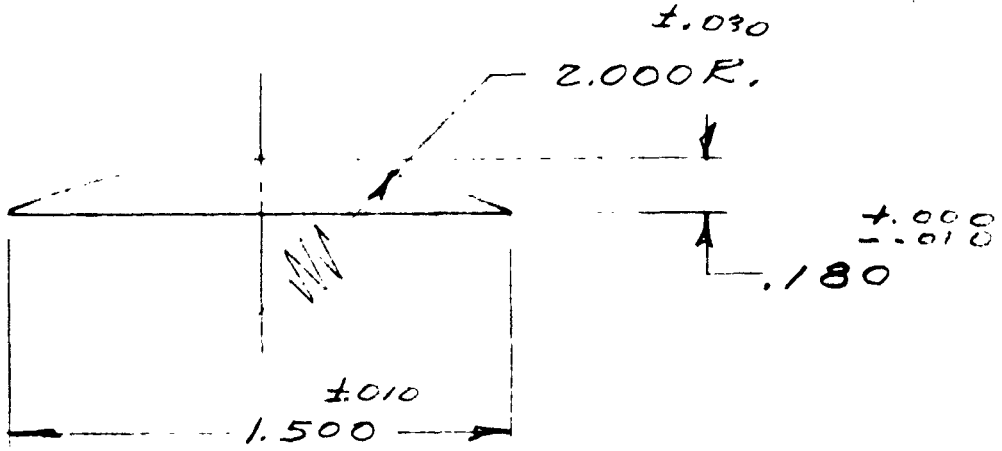
DRAWING & ISSUE NO. Z-24595 1

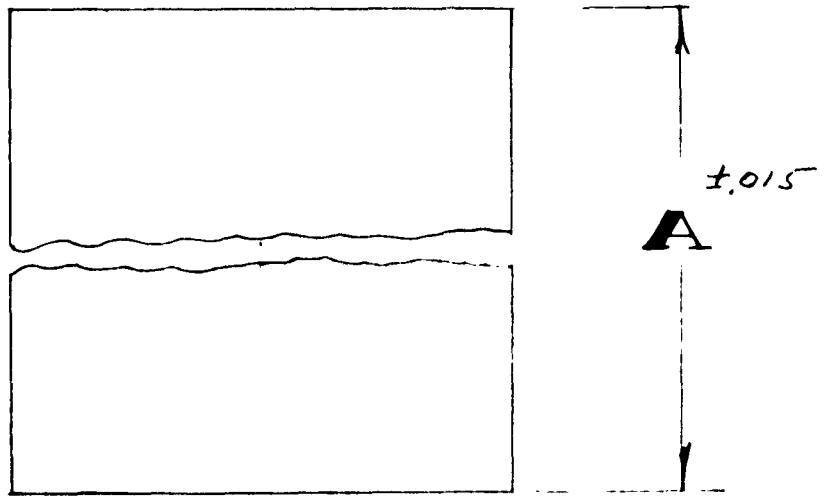
DESCRIPTION SPACER 3.950 I.D.

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON - ZYTEL #101			6.900			1
2	NYLON - ZYTEL #101			8.690			1





IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

Z24595 1

DRAWN BY

CHECKED BY-

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES USED ON

FIG-30

SONOTONE CORP. ELMSFORD, N. Y.

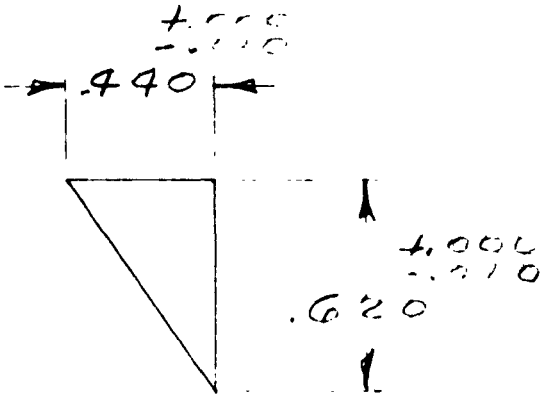
DRAWING & ISSUE NO. Z-24594 1/2

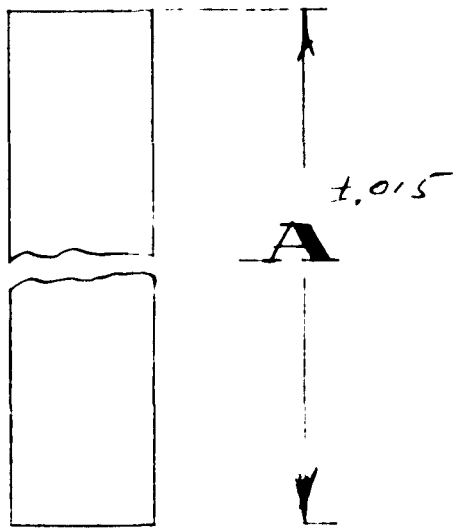
DESCRIPTION SPACER - CORNER 3.950 I.D. A

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYCON ZYTEL #101			8.690			1
2	NYCON - ZYTEL #101			7.250			1





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DO NOT SCALE DRAWING

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CHECKED BY:

ENG. APPROVAL

REG. APPROVAL

CHANGES

ASSEMBLIES USED ON

FIG - 31

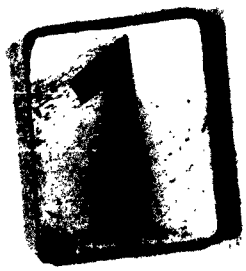
SONO

DESCRIPTION QU

SCALE FULL

ITEM	DESCRI

±.060
.300



±.060
9.320

CHANGES

ES. APPROVAL

NG. APPROVAL

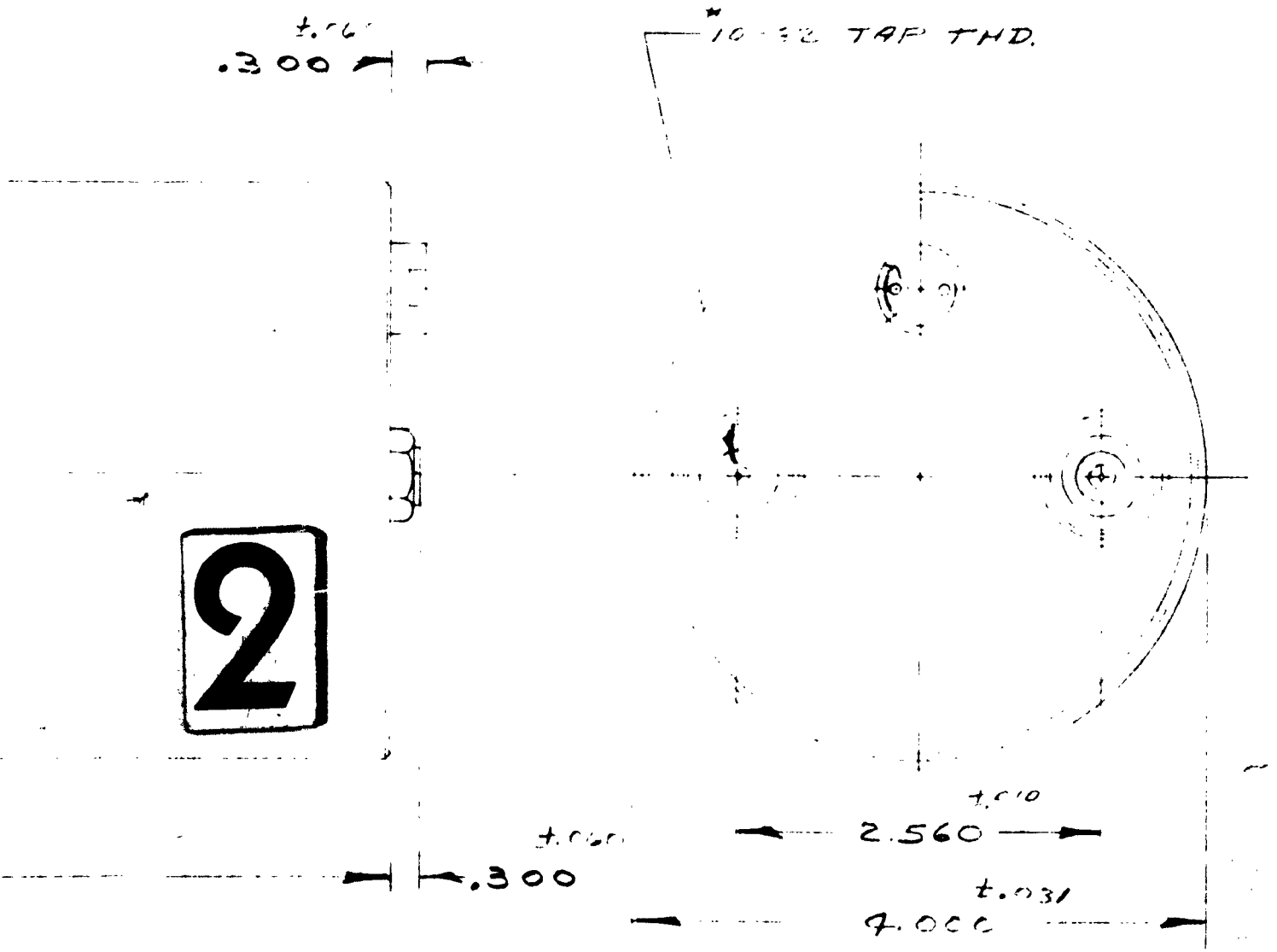
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO. Y-25191

DESCRIPTION OUTLINE DWG.-100AH.-3.950I.D. CERAMIC

SCALE FULL BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.



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P-1469

DO NOT SCALE DRAWIN

ASSEMBLIES USED ON

IN REFERRING TO THIS DRAWING STATE DRAWING NUMBER AND ISSUE NUMBER

Table VII

Cell Weights

Cell Type	Core	Electrolyte	Case, Cover Terminals, etc.	Total
BB440/U	Av. 0.68# Range 0.02#	0.13#	Av. 0.57# Range -	Av. 1.38# Range 0.05#
BB441/U	Av. 3.33# Range 0.18#	0.64#	Av. 1.94# Range -	Av. 5.91# Range 0.17#
BB442/U	Av. 6.43# Range 0.28#	1.23#	Av. 3.24# Range -	Av. 10.90# Range 0.27#

AD____________ Accession No.________
Sonotone Corp., Elmsford, N.Y.

DESIGN AND MANUFACTURE OF SEALED
NICKEL-CADMIUM CYLINDRICAL CELLS

F.Alliegro, W.Ryan, G.Baumstark, A.B.Mundel

Final Report, 1 December 1959 to 31 March 1963
79 pp 32 Illus., 7 Tables
Signal Corps Contract DA-36-039 SC-84496
DA Task No. 3G18 03 011 02, Unclassified Report

The sixty cells of each of three sizes (10 A.H., 50 A.H. and 100 A.H.) have been manufactured.

The qualification tests of SCL-7504A have been successfully passed and all cells have been delivered.

All 10 A.H. and 50 A.H. cells had teflon sealed terminals.

In the 100 A.H. size, 40 cells had teflon seals and 20 cells had ceramic seals.

Fifty each of the 50 A.H. and 100 A.H. cells have been partially scored to immobilize the core assembly in order to withstand the severe vibration and shock requirements of SCL-7504A.

Parts lists and pertinent drawings of all types of cells have been included in this report.

UNCLASSIFIED

1. Batteries - sealed
2. Batteries - Nickel-Cadmium

Contract DA-36-039 SC-84496

AD____________ Accession No.________
Sonotone Corp., Elmsford, N.Y.

DESIGN AND MANUFACTURE OF SEALED
NICKEL-CADMIUM CYLINDRICAL CELLS

F.Alliegro, W.Ryan, G.Baumstark, A.B.Mundel

Final Report, 1 December 1959 to 31 March 1963
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Signal Corps Contract DA-36-039 SC-84496
DA Task No. 3G18 03 011 02, Unclassified Report

The sixty cells of each of three sizes (10 A.H., 50 A.H. and 100 A.H.) have been manufactured.

The qualification tests of SCL-7504A have been successfully passed and all cells have been delivered.

All 10 A.H. and 50 A.H. cells had teflon sealed terminals.

In the 100 A.H. size, 40 cells had teflon seals and 20 cells had ceramic seals.

Fifty each of the 50 A.H. and 100 A.H. cells have been partially scored to immobilize the core assembly in order to withstand the severe vibration and shock requirements of SCL-7504A.

Parts lists and pertinent drawings of all types of cells have been included in this report.

UNCLASSIFIED

1. Batteries - sealed
2. Batteries - Nickel-Cadmium

Contract DA-36-039 SC-84496

AD____________ Accession No.________
Sonotone Corp., Elmsford, N.Y.

DESIGN AND MANUFACTURE OF SEALED
NICKEL-CADMIUM CYLINDRICAL CELLS

F.Alliegro, W.Ryan, G.Baumstark, A.B.Mundel

Final Report, 1 December 1959 to 31 March 1963
79 pp 32 Illus., 7 Tables
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